

Assignment-specific stress inoculation training for highly specialized IT personnel

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As a result of their institutional assignments, highly specialized information technology (IT) personnel often find themselves in unpredictable and complex situations with a high level of difficulty. The complexity of the tasks to be carried out and the management of these tasks have set new challenges for this category of personnel. It is all the more important, therefore, that the personnel employed should acquire differentiated stress control techniques during qualifying training to develop a long-term performance capability. Following up on the earlier mentioned challenges, an assignment-specific stress inoculation training for highly specialized IT personnel is being introduced against the background of relevant stressors in the context of IT.

Keywords: stress, stress inoculation training (SIT), resilience, highly specialized IT personnel

Introduction

Due to the constant and evolving technological progress, the competitiveness of enterprises is closely connected with the performance of highly specialized information technology (IT) personnel (e.g., software development and integration; IT architecture; IT; process automation in artificial intelligence; information and data analyses; and IT security (1). The aforementioned group of people is distinguished in particular by assignment-specific capabilities and skills that enable them to acquire order-based qualifications and to continuously adapt these qualifications to extreme situations (2). Overall, people who work in IT are often considered a high-level asset (Ridl and Zwettler, 2010). Therefore, to render personnel recruitment more effective and prevent personnel fluctuation, personnel development measures for maintaining and enhancing performance and building mental resilience are increasingly moving into the organizational focus (3–5) besides the strategic fields of action of recruitment and staff retention (Reichsteiner, 2016; 6; 7).

When considering measures for maintaining and enhancing performance within the meaning of resilience, a

discussion of the factor of stress is of substantive significance (8). In this context, stress is described as an unspecific (psycho-physiological) response to burdens (stressors). Especially in the workplace, both physical and mental well-being can be massively affected (3, 9). The impairment itself often has a negative impact on the productivity, effectiveness, and quality of work (10). It appears all the more important to not put the focus on getting rid of all stress-inducing factors in the workplace (which is impossible), but rather and in particular on enhancing resilience, which is understood to signify resistance to stress and trauma (11, 12). Resilience permits overload situations at the workplace to be adequately dealt with as far as possible without the staff becoming mentally weakened by them (13).

Special challenges, consequences, and approaches to solutions in IT

It is repeatedly emphasized that the organizational framework conditions in IT are often characterized by project-specific structures, which are accompanied by long-term stress factors, such as time pressure, frequently

changing goals, and high workload Longenecker et al. (14) emphasize that, according to IT professionals, a lack of planning security due to the job, as well as unproductive resource allocation and changing (often contradictory) objectives, often prevail in IT work. Frequent and abrupt changes in change processes, unrealistic expectations, and ineffective team management were all stressors. Very high-quality requirements and the need for constant career expansion due to (1) the constant developments in the cyber world and (2) the wide range of technical activities required further stressed them (15). Both were accompanied by low levels of (also a lack of interest in) interpersonal teamwork (2, 16). Inadequate social and communication skills, therefore, often lead to conflictual disputes between managers and IT staff (14). In this context, highly specialized IT staff tend to be less interested in understanding others, making efficient and solution-oriented communication almost impossible, especially when managers are not IT experts themselves (2). Furthermore, role ambiguity and the experience of competition as dysfunctional variables have a negative impact on social cohesion within IT teams (17). Rao and Chandraiah (18) pointed out, however, that both junior and senior IT managers experience job stress, which correlates negatively with mental health.

Furthermore, Tsai et al. (15) emphasized that inadequate coping with this strain carries the risk of a higher absentee rate, burnout, or the desire for a change of occupation.

Moreover, further research shows that in IT, a high level of occupational stress strongly increases the risk of developing depression and consuming large amounts of alcohol as a coping mechanism (17, Darshan et al., 2013). Furthermore, there are reports of a harmful sleep-wake cycle that degrades performance owing to (IT branch-specific) overtime or night shifts (19).

As noted earlier, Rao and Chandraiah (18) point out that organizations could introduce stress management programs that should encompass individually oriented strategies, such as relaxation techniques, biofeedback, or meditation to minimize stress. In this context, Gerlmaier and Latniak (20) highlight the importance of factors, such as creating individual leeway, providing opportunities for recreation at the workplace, or the quality of management of IT specialists. In addition, Raghavan et al. (21) report that, among other things, flexible working hours, adequate support of employees, or subject-related training can alleviate stressors, such as role ambiguity and the absence of leeway for decision-making and improve the overall perception of work stress. Bolhari et al. (22) emphasized time and again that IT specialists, notwithstanding their (very) stressful jobs that put a great strain on them, have so far been unable to gain significant experience with stress management programs. Building on these results, Shanthi (2016) suggests stress management programs, a workplace design that includes physical activity, programs aimed at a change in lifestyle, the identification of stressors, or a supporting

organizational culture as means of counteracting the negative effects of stress.

Stress management

In this context, stress management is regarded as a generic term that encompasses methods and techniques for reducing mental strain (23). It aims at the adaptive handling and successful management of external and internal stressors (23–25). Stress management is made up of several segments building on one another, which, in their entirety, include all aspects of successful coping with strain.

As part of a resilience project for the Bundeswehr Military Police, Steingraber et al. (25) designed an assignment-specific stress management concept with the objective of (1) contributing to stress competence within extreme groups, thereby (2) achieving long-term mental strengthening (5, 25–28). In this way, when selecting techniques and methods, a distinction was made between stress prevention, stress control, and stress management. The concept is based on the identification of areas of action that establish a link between stress and its management within the scope of balancing strain and compensation (29). Meichenbaum (30) asserted that where the buildup of stress competencies is concerned, stress inoculation training (SIT) is used in most cases, as stress competencies do not develop from avoidance but by successfully dealing with challenges.

Assignment-specific SIT

Stress inoculation training (SIT) is a complex behavioral training requiring the use of cognitive and motor skills to build up competencies in coping with stress during its peak phase. Broadly speaking, SIT can be seen as an instrument intended to induce artificial stress to make the individuals affected apply and train the stress control techniques they have previously acquired (30).

Stress inoculation training (SIT) can be carried out in an assignment-specific manner and adapted to all fields of activity. Consequently, based on stress management according to Steingraber et al. (25), an assignment-specific SIT was designed for highly specialized IT personnel. This assignment-specific SIT is to enable the target group to (1) recognize and analyze dysfunctional emotions, thoughts, imaginings, and behaviors and link them to triggering stressors; (2) train problem-solving strategies; (3) actively regulate emotions and stress; (4) use maladaptive responses as cues for activating their stress control techniques; (5) acquire sufficient knowledge about effective stress control techniques and enhance their self-reflection and their repertoire of stress control techniques with a view to coping with (un)expected stressors. Assignment-specific SIT is made up of (1) a psycho-educative communication of knowledge

with a (2) self-reflection component (information and practice phase); (3) the practice of stress control techniques and interventions; and (4) a systematic stress induction (hands-on phase) where the contents previously learned are to be applied.

It is imperative that the psycho-educative communication of knowledge should sensitize individuals to the subject of stress, including stress in an organizational context, and, in particular, contain an in-depth understanding of the impact of stress and the interdependencies between stress control techniques and stress responses (25). This communication of knowledge must not be looked at in isolation but planned as a combination of theory and practice.

The ability and willingness to engage in self-reflection has special significance when acquiring a high level of stress resistance (31). Self-reflection is understood as a deliberate confrontation with oneself to enhance one's perspective through new insights into situations and oneself. Self-reflection can be described as result-oriented if conclusions for future action or with regard to one's own person are developed in its course (32).

From the large number of stress control techniques, the ones listed below have proved learnable and feasible as far as assignment-specific SIT is concerned:

- (1) Self-verbalization: Self-verbalization seeks to alter conceptual self-instruction to produce problem-oriented coping strategies and reduce arousal in stressful situations (33).
- (2) Goal-Setting/Segmentation: Goal-setting/segmentation refers to strategies that can be used to focus attention and resources on a goal or to break up goals into smaller intermediate goals that are easier to attain (Miecznik, 2013).
- (3) Relaxation techniques: The short version of progressive muscle relaxation according to Jacobson is a possible technique in this context (34). It aims to induce a state of relaxation, especially when applied in a phase of high stress.
- (4) Arousal control: This technique receives the most attention in connection with assignment-specific SIT: It is about controlling the physiological impact of a stress response and focuses on techniques for controlling breathing or the heart rate (35).

Effective systematic stress induction requires a supportive SIT atmosphere. The SIT atmosphere signifies a training framework that enables the stress level required for a challenge to be achieved and that permits and promotes the application of the relevant techniques. The training framework must be chosen and shaped in such a way that stress-reducing factors (lack of seriousness, relativization of the relevance) do not affect and interfere with the systematic stress induction. An atmosphere supportive of practice

during the systematic stress induction is characterized, for instance, by (1) a realistic replication of the training situation and the stress amplifiers (in this case in conformity with assignment-specific activities in the IT sector); (2) variety regarding the stressors (multifactorial strain); and (3) sensitivity and goal orientation of the instructors vis-à-vis the training program and the training participants. It is important to ensure that factors with a detrimental effect on assignment-specific SIT should be eliminated before the start of training and that both the instructors and the training participants should be prepared and sensitized accordingly. In addition, the more realistic and supportive the training phase, the greater the learning progress that can be made (30). The assignment-specific SIT is shown in **Figure 1**. The model is explained in more detail later.

Depending on the training project, systematic stress induction can be undertaken as part of individual or group training. In both variants, assignment-specific and non-assignment-specific activities (tasks) may be incorporated as a basis (of long-term stress amplifiers). The individual activities are complemented and intensified by focused short-term stress amplifiers to increase, maintain, or reduce the individual stress level within the desired framework.

Assignment-specific activities are tasks closely related to the real-life activities of the relevant assignment/order. In the case of a systems analyst, for instance, such activities may include the customized development of a software or hardware system. For one thing, the focus may be on basic expertise via programming languages, system modeling, and requirements engineering but also on interdisciplinary competencies such as abstract thinking, analytical skills, and excellent communication skills as an individual accomplishment or, in the case of a development team, as a group accomplishment.

Short-term stress amplifiers

Short-term stress amplifiers are added tasks/activities employed in a focused manner, besides the assignment-specific activities. Their use aims to deliberately complicate the assignment-specific activities through multifactorial challenges. They can be modeled since their intensity can be changed depending on the situation, which is to say that the stress level of the training participants can also be adapted individually and in accordance with the situation. Depending on the task, they can be allocated to the categories listed below: (1) (Sensory-) motor skills are defined as the visible execution of movements and basic skills (36). In the context of IT, the coordinating capability, for example, is to be highlighted in particular. (2) Cognitive skills are used to solve problems and carry out tasks. The (complex) ability to solve problems, such as the analysis of faulty software and hardware systems, is regarded as an important individual skill in this context, which enables the individual to recognize

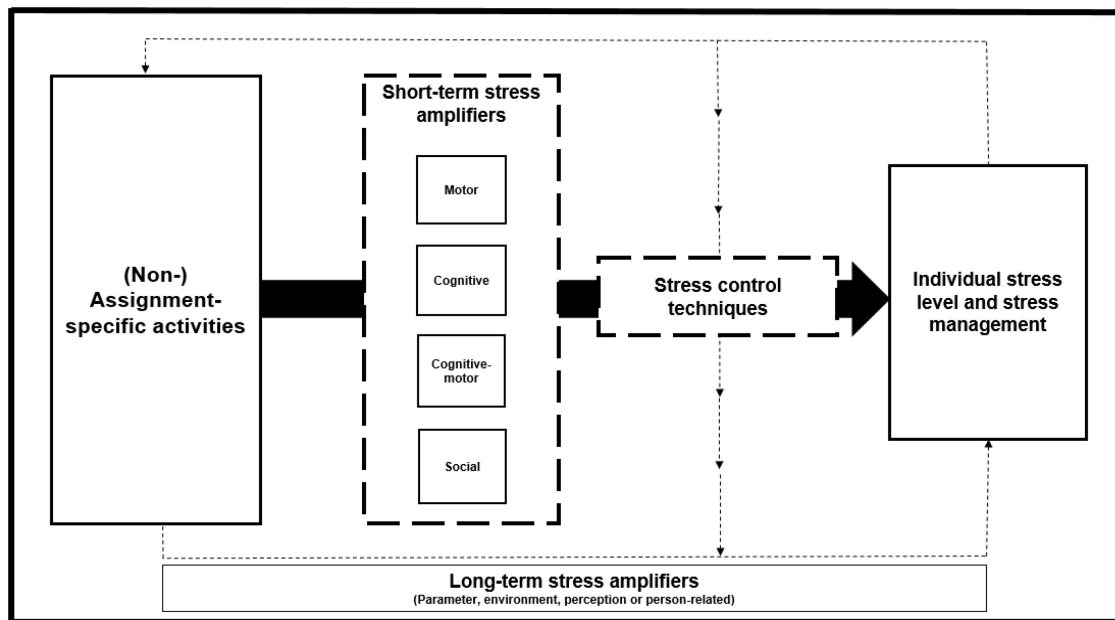


FIGURE 1 | Systematic stress induction during an assignment-specific SIT.

the problem, understand it, and solve it by logically linking cause and effect chains (37). (3) Cognitive-motor skills that connect the cognitive mechanisms with motor performance (38). The faultless use of the 10-finger system is, among other things, fundamental to the underlying context here. (4) Social skills that permit effective action in situations of communication and interaction. Communication skills, teamwork abilities, leadership qualities, intercultural competencies, critical faculties, and the ability to deal with conflict are all components of social skills (39). Social skills are to be assigned a central role, especially in the framework of project-type IT structures.

Overall, the short-term stress amplifiers complement the assignment-specific or non-assignment-specific activities, which represent long-term stress amplifiers, by multifactorial burdens. Depending on the stress level required, the tasks assigned to the training participants may be increased or reduced in terms of difficulty or frequency.

Long-term stress amplifiers

Long-term stress amplifiers must be construed as meaning permanent stressors. Like their short-term counterparts, they are aimed at stress level modeling and impacting on the performance of the (non)assignment-specific activities. However, long-term stress amplifiers are not only applied selectively but also over a longer period. Furthermore, they can be modeled and adapted in terms of their intensity, if necessary. Long-term stress amplifiers may be categorized in the context of this systematic stress induction during an assignment-specific SIT as follows:

- Framework-related long-term stress amplifiers. They refer to all general assignment and task-related factors concerning the conditions of the exercise. In the case of a system analysis, such conditions could be the allotted amount of time, the size of the system to be analyzed, a variety of programming languages, or the resources made available, for example. Hence, they constitute additional long-term stress amplifiers, which, following on from the task, are permanently present but can be modeled, if need be.
- Perception-related long-term stress amplifiers. They refer to all factors that have a negative effect on the processing of sensory stimuli. These stress amplifiers can be auditory (e.g., loud sustained background noise interfering with picking up important pieces of information) or visual (e.g., darkness that impedes the recognition of system-relevant hardware or the operation of instruments). If the senses of smell, taste, or touch are relevant to the training, olfactory, gustatory, and tactile stress amplifiers also belong in the above category (e.g., burnt smell to simulate a short circuit or a defective hardware component).
- Environment-related long-term stress amplifiers. They refer to all factors arising from environmental conditions. For example, these could encompass the targeted use of heat, or narrow spaces and heavy pieces of equipment that severely restrict freedom of movement or cause increased physical strain.
- Person-related long-term stress amplifiers. They refer to all factors arising from human sources. For example, these include “nuisance” calls or stress-inducing behaviors of a co-worker or customer toward the training participants (e.g., constant

questioning of the measures carried out, contradictory behavior of role players). A further person-related long-term stress amplifier—and it is imperative that this be considered—results from the group of participants/observers. The presence of superiors or the size of the observer group could *inter alia* result in persistent assessment or performance stress.

In addition, within SIT, long-term stress amplifiers that do not lend themselves to modeling must be considered too. Basically, it is up to the instructors themselves to decide whether the desired stress level has been attained and which stress amplifier should be adapted to what extent. **Table 1** gives a survey of the types of stressors that can be employed, their characteristics, and the manner in which they can be implemented by short-term or long-term stress amplifiers.

SIT stress levels

A stress level of 60–70% is to be aimed for during the assignment-specific SIT to require the techniques to be applied while, at the same time, avoiding overburdening. Too little stress would not call for the techniques to be applied, while too much stress would put the training participants

in a state similar to mere endurance where serious attempts at regaining control are not permitted (40). Therefore, it is necessary, in particular, that the instructors conducting the assignment-specific SIT should operationalize the stress levels, as they have to adapt the stress amplifiers in accordance with the requirements of the situation.

The parallel use of biofeedback is a suitable means of expounding the possible effect of assignment-specific SIT and encouraging self-reflection in the training participants as an impetus for a process of growth. Biofeedback is understood to mean generating awareness of physical processes, such as breathing or the heart rate (41). These are particularly suited to illustrating the stress level on the basis of objective parameters in the course of real-time evaluation and using the stress level to enhance self-reflection. The above-mentioned classification of the individual stress levels required for SIT can be seen in **Table 2**.

Individual stress management and stress level

Individual stress management is understood to mean the entire repertory of techniques for stress prevention, stress

TABLE 1 | Task-related stressors.

Stressors	Descriptions	Possible implementations
Perceptual stress	Perception is the process of the sensory organs picking up and processing environmental stimuli. Overload or lack of stimuli may have a stressing effect.	Increased ambient noise Field of view restriction Darkness Burnt smell.
Conflict of interests between participants and the customer	A conflict of interests arises from the clash of different interests. Solving the conflict can have a stressing effect and, among other things, requires the ability to deal with conflict, the ability to work in a team, tolerance for other opinions, etc. “Losing” this conflict may result in cognitive dissonance.	The training participants are given contradictory information about a problem and have to find a consensus. No agreement on the solution with the customer.
Time pressure	Time pressure means being pressured to meet certain deadlines. This state of affairs is perceived as stressing.	Limited time for mission accomplishment Time pressure from instructors Time reduction during task performance.
Loss of information	Reduction in the value of information during the information flow of a communication phase. Missing or limited information and poor communication result in ignorance and uncertainty.	Restricted communication as a result of a telephone/an Internet connection susceptible to malfunction, for example. Divergent information Wrong information by the customer.
Pressure to perform	Pressure to perform signifies the psychological pressure that arises from being forced to do very well.	Exercise as a competition Negative feedback on the current performance Demanding a very high minimum performance level.
Assessment stress	An assessment is a value judgment about a state of affairs, a situation, attributes or a person. An assessment can have a stressing effect, especially if a person wishes to do well.	Performance induction by observers (e.g., superiors obviously observe what is happening).
Loss of team automatism	A team is an active group of individuals whose overall performance exceeds the sum of the individual performances because of the way in which the team members cooperate. The breakup of well-rehearsed teams may have a stressing effect since communication and cooperation are disrupted and the team members have to attune themselves to a new person.	Allocation of new teams Breakup of the usual team structures and reassignment of roles Incorporation of a handicap (e.g., individual training participants are prohibited from communicating for several minutes).

TABLE 2 | Three stress levels and the challenges associated with them.

30–40% stress level	60–70% stress level	100% stress level
Low stress level; the focus is on testing the techniques; not assignment-specific (but an assignment-specific context is possible) Practice	Moderate stress level; mission and assignment-specific stress; application of the techniques in an assignment-specific context; application of the techniques a necessity Application/Challenge	Maximum stress level; loss of control; tunnel vision; persistence behavior→; application of the techniques taught not possible Overburdening

control, and stress management as well as their (successful) application (25).

The following applies: The more diverse and better rehearsed the techniques of intervention, the more effective and accurate their employment. It is only when the training participants process the situations experienced and benefit from them (e.g., courses of action for similar future situations, knowledge about their own responses, and adaptive actions for subsequent situations) that they will be able to enhance their stress resistance and perform their assignment-specific activities without a significant performance degradation (feedback loop).

Summary and outlook

In summary, a review of the literature shows a focus on both qualitative and quantitative investigations that identify and assess relevant stressors in the workplace. Furthermore, it was possible to identify a large number of recommended methods and/or measures for enhancing stress resistance. These extend from general measures such as the individual identification and elimination of stressors, to complex stress management strategies at the organizational level or individual stress management programs. It emerges, however, that these programs are merely mentioned as potential means of stress management without going into the various cause and effect chains in the sense of prevention, control, or coping. So far, the majority of the studies focus on stress management without examining stress control in an acute stress situation as experienced by IT experts.

In conclusion, it should be noted that a preventively effective SIT for highly specialized IT professionals that is oriented toward the current challenges can make a decisive contribution to expanding their individual performance limits. However, it is imperative that practicable and suitable stress control techniques be taught during the preparation of the training. The realism of the training is a salient key to success in this context. As a consequence, it is necessary to

adequately identify and appropriately consider the respective task and assignment-specific stressors and their complexity. In addition, it is important to continuously evaluate and, if necessary, adapt both the effectiveness and efficiency of the training in view of the constant changes in the professional field of information technology.

Furthermore, the training model permits interdisciplinary implications to be derived for the specific preparation of highly specialized personnel. For instance, it would be conceivable, to extend the underlying model to executive personnel (27). Besides, it is to be noted that the one-time conduct of SIT is not necessarily sufficient for the lasting promotion of different (stress-reducing) effects. A long-term effect calls for stress control techniques to be applied over a long period of time and to be supplemented by stress prevention and stress management techniques. It will become all the more challenging to achieve sustainable results, especially if the assignment-specific SIT fails to take account of the relevant organizational particularities. This observation is also emphasized by Meichenbaum (30) in the sense that going beyond the individual is called for.

Hence, owing to the situational and extremely individual (stress) responses during SIT, it makes sense to use biofeedback for objectively observing the individual stress level. For one thing, this would facilitate the modeling of the individual stress amplifiers by those conducting the training, and for another, it would promote the training participants' self-reflection on the basis of objective parameters. Also, additional technology-based tools such as the use of virtual reality technology (VR technology) would have to be considered entirely appropriate. In particular, the latter could contribute to greatly marginalizing the costs of an assignment-specific SIT. From a holistic perspective, SIT is a complex tool that poses special challenges not only for the training participants but also for those conducting the training. It is by no means a cure-all. On the contrary, the transactional consideration of stress-triggering variables continues to exist. It is necessary, therefore, to expand, intensify, and promote interventions at the group and organizational level.

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