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IMPROVING WORKING ABILITIES, ACHIEVEMENT MOTIVATION, AND ACTIVE AGEING IN OLDER WORKERS

Eric Schmitt (a), Jörg Hinner (b)*, Andreas Kruse (c)
*Corresponding author

(a) Heidelberg University, Bergheimer Strasse 20, 69115 Heidelberg, Germany, eric.schmitt@gero.uni-heidelberg.de
(b) Heidelberg University, Bergheimer Strasse 20, 69115 Heidelberg, Germany, joerg.hinner@gero.uni-heidelberg.de
(c) Heidelberg University, Bergheimer Strasse 20, 69115 Heidelberg, Germany, andreas.kruse@gero.uni-heidelberg.de

Abstract

Problem Statement: As a consequence of an aging labor force, companies' competitiveness depends more and more from their ability to recognize, support, and effectively use older employees' potentials for innovation and creativity. Research Questions: Do modular vocational trainings substantially contribute to enhancement and maintenance of working abilities, achievement motivation and active ageing in older workers by improving mental and physical fitness, and health behavior? Purpose of the Study: To put the practicability, effectiveness and sustainability of multidimensional modular intervention measures integrating cognitive training, physical training, and health education which were attuned to specific needs of diverse occupational contexts to an empirical test and further contribute to foundational research in the field of intervention programs for an ageing workforce. Research Methods: Longitudinal analyses of cognitive, physical, and health behavior-related intervention effects and sustainability in samples of older workers (45 years and older) who participated in vocational trainings developed and implemented in co-operation with Robert Bosch GmbH and Robert Bosch Foundation, Deutsche Bahn, Municipality of Heidelberg, and Chemical Industry. Evaluation of intervention effects against changes observed in a control group. Findings: All four versions of the program significantly (and substantially) improved indicators of cognitive and physical fitness, including information processing speed, concentrativeness, inhibition, working memory capacity, physical strength, endurance, and coordination. Individual counselling sessions suggest increases in health behavior, control beliefs, and overall optimism. Effects slightly decreased following end of vocational training but nevertheless provide evidence for sustainability of the program. Conclusions: Modular multidisciplinary approach and focus on the development of more general competences significantly contribute to the innovative character of the program. A particularly innovative component of the didactic concept is the private continuation of training units in everyday contexts (on the basis of individual advices, feedback, and materials offered before) which again is followed by training units in the company.

Keywords: Active ageing, older workers, vocational training.

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1. Introduction

Plasticity of ageing processes belongs to the basic propositions in Gerontology (Kühn & Lindenberger, 2016; Raz & Lindenberger, 2013). Empirical studies have shown that experiences, knowledge systems, action competence, and behavior patterns, which were developed in middle adulthood in working contexts, family, and leisure time, have a profound impact on healthy life styles as well as on patterns of cognitive, emotional, and social activity in older adulthood. As a consequence, working contexts are highly important for the realization of the guiding principle of healthy and active ageing (Foster & Walker, 2014; Kooij, 2015). The same is true for potentials of human creativity and productivity in older adulthood: They are also basically influenced by person-environment-constellations in middle adulthood (Lachman et al., 2015). If it is further possible to successfully diminish health risk factors in middle adulthood (which is particularly important in working contexts), to establish and strengthen health-related behavior (in the sense of effective self-regulation and self-design), and to impart behavioral techniques which can contribute to effective coping with tasks and challenges, and thereby also contribute to physical and cognitive fitness, individuals hold good requirements for healthy and active ageing. Moreover, respective realization of potentials is not only a rewarding task for individuals but also for companies and the society as a whole (Kruse & Schmitt, 2012). Particularly in times of population ageing society's prosperity cannot be maintained alone by utilization of the potentials of younger people. As a consequence of an aging labor force, companies' competitiveness depends more and more from their ability to recognize, support, and effectively use older employees' potentials for innovation and creativity. Design of protective working environments, adjustment of working conditions and offering opportunities for extended vocational training belong to the criteria of the companies' "demographic fitness" (Adecco Institute, 2008; Antoniou et al. 2017).

In several research projects, an interdisciplinary, modular intervention program has been developed and evaluated in co- operation with Robert Bosch GmbH and Robert Bosch Foundation, Deutsche Bahn, Municipality of Heidelberg, and Chemical Industry. In all these projects, specific content, measures, basic conditions and organization (including number, duration, and timing of training sessions) have been attuned in detail to the specific interests, preferences, and needs of respective economic contexts. The program was awarded with first place in the category development and implementation of concepts, Human Excellence Awards 2013, German Employers' Association. It integrates effective measures from three disciplines, i.e. medicine, psychology, and sports. This program is distinctly not aimed to contribute only to a better performance due to advances in single abilities and skills. Instead, the program targets more general development of cognitive, physical, and emotional competence; not only working abilities and achievement motivation, but also maintenance of physical and mental health together with personal meaningful activity, which is understood also as a basis for social inclusion and participation. Consequently, the program is intended to have a lasting impact on individual competences of self-regulation and self-design, and thereby also on the course of individual ageing processes.

In this paper we elucidate the theoretical and empirical background of the program and provide evidence for its practicability, effectiveness, and sustainability in different occupational contexts.

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2. Problem Statement

Numerous empirical studies suggest that development of cognitive abilities can be fostered by training of basic cognitive processes, physical activity, and health-promoting behavior (Kelly et al., 2014; Lindenberger, 2014; Rahe et al., 2015; Shatil, 2013). Our modular training program not least rests upon recent theoretical approaches and empirical findings on the possible causes of age differences in cognitive functioning, particularly in fluid intelligence or cognitive mechanics (Baltes et al., 1999). Respective research strongly supports the proposition that age-related decreases in basic cognitive processes, "processing primitives", do not only have an impact on performance in speed tests (i.e. tasks with low difficulty) but also on performance in more sophisticated power tests (Salthouse, 1996), and can explain for most age-related variance in cognitive functioning: "large proportions of the age differences are associated with general influences shared across different types of cognitive measures" (Salthouse, 2017, p. 11).

In this context, particularly speed of information processing (Salthouse, 1996), inhibition (Amer & Hasher, 2014; Hasher & Zacks, 1989), and capacity of working memory (Conway et al., 2003; Kane et al., 2004) deserve closer consideration. Too slow processing of information can prevent successful completion of necessary operations or facilitate that information from earlier steps of information processing is no longer available or obsolete (i.e. no longer accurate) when needed in later steps of information processing. Similarly to the speed of information processing, the ability to ignore irrelevant or distracting information, to inhibit interfering associations, "nongoal path ideas" (Hasher & Zacks, 1989), and to concentrate on the information actually needed declines not later than in middle adulthood. The same is true for capacity of working memory, i.e. the amount of information which can be processed simultaneously in short term memory. However, results of intervention studies show substantial plasticity: speed of information processing, efficiency of inhibitory processes, and capacity of working memory can be increased by adequate training measures, with training gains not restricted to short-term changes in level of abilities but also reflected in more favorable developmental trajectories (Bherer, 2015, Greenwood & Parasuraman, 2016).

Further findings show that regular physical activity, partly directly, partly mediated through the promotion of basic cognitive processes, has a favorable effect on the development of cognitive abilities (Bamidis et al., 2014). Results from training research suggest that efforts to improve cognitive performance are most likely to be successful if one does not rely on purely cognitive training, the effects of which are often limited to the specific content of the training, but on a combination of cognitive training and physical training (Rahe et al., 2015).

In addition to basic cognitive processes and physical activity, health-promoting behavior has a substantial impact on the development of job performance (Merrill et al., 2013; van Scheppingen et al., 2015). Human development reflects a dynamic and continuous interplay between person and environment, with people explicitly conceived of as agents of own development. Development of working abilities does not simply reflect normative age-related changes beyond the scope of individual influence. Instead, engaging in self-responsible health behavior – e.g. avoidance of risk factors, diet or coping with stress – significantly contributes to the maintenance of physical and intellectual abilities.

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Experimental research shows that interindividual differences in basic cognitive processes, physical activity, and health behavior not least reflect activation of age stereotypes (Dordoni & Argentero, 2015; Hess et al., 2009; Levy, 2003, 2009; Walton et al., 2015). Longitudinal studies suggest that interindividual differences in age stereotypes and attitudes towards own ageing (sometimes referred to as "self-stereotypes") are reflected in developmental trajectories of physical and mental health, culminating in development of dementia and mortality (Levy, Ferruci et al., 2016; Levy, Slade et al., 2002; Levy, Zonderman et al., 2009).

The interdisciplinary modular program can be described as a combination of three pillars we consider as necessary for sustainable maintenance or improvement of working abilities, achievement motivation, and active ageing in older workers. (1) Cognitive training measures are intended to improve basic cognitive processes. More specifically, participants are informed about different dimensions of human intelligence, age-associated changes, influencing factors, plasticity and malleability. Typical tasks from established test procedures are worked out and explained, possible solution strategies are discussed and used in new tasks. As a consequence, participants should not only show increased performance in cognitive tasks. Moreover, they should learn that they themselves have control over a good part of cognitive ageing and afterwards increasingly engage in respective self-regulation processes. (2) Physical training during the intervention period on the one hand harks back to synergies resulting from combination of cognitive and physical activities. On the other hand, participants should be motivated to further integrate physical activities (e.g. walking, pilates, progressive relaxation) into everyday life. The experience of improvements in physical performance was expected to have a positive influence on self-efficacy beliefs and thus on the sustainability of the qualification measures. At the same time, improvements in physical fitness are not a primary objective of the modular program, because of regularly high heterogeneity of performance levels and lifestyles, and the comparatively short intervention period. (3) With the third pillar, information on health development, existing knowledge on the course, influencing factors and notably plasticity and malleability of biological, psychological and social ageing processes should be supplemented, structured, related to individual life situation, and not least integrated into individual recommendations for behavior change (including techniques of self-regulation) which are optimally attuned to individual resources, concerns and preferences. Based on this approach, participants were offered the following overarching topics in the field of health care: stress and stress management, nutrition, communication, age stereotypes and ageing processes, sleep and relaxation, prevention and health promotion.

The multidisciplinary approach and the focus on the development of more general competences significantly contribute to the innovative character of the program. Particularly innovative components of the didactic concept are (1) discussion and selection of alternative training units with participants in the beginning, (2) confidential medical examination, (3) multiple individual testing of physical and cognitive abilities, and (4) the private continuation of training units in everyday contexts (on the basis of individual advices, feedback, and materials offered before) which again is followed by training units in the company.

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3. Research Questions

The basic research question of the present paper is whether modular vocational trainings substantially contribute to enhancement and maintenance of working abilities, achievement motivation and active ageing in older workers by improving mental and physical fitness, and health behavior. More specifically, we are interested in changes in basic cognitive and physical abilities, attitudes towards own ageing, control beliefs, overall optimism, health consciousness, risk factors and health-promoting behavior which regularly result from participation and cannot be observed in a control group within the same observation period.

Proceeding from the sketched theoretical and empirical background we hypothesize that sustainability of intervention effects, i.e. continued existence of new established differences between intervention group and control group is a valid indicator for differences in longer-term developmental trajectories, i.e. lasting benefit for individual participants as well as for companies. Naturally, this basic assumption cannot be put to an empirical test in research co-operations lasting only for few months. We argue that the impact of modular training on developmental processes which are reflected in long-term job performance as well as effective self-regulation and active ageing substantially depend on individual motivation and complementary opportunity structures to further engage training, education, and self-responsible developmental regulation processes.

4. Purpose of the Study

Using data from four research co-operations representing a variety of occupational contexts we put the practicability, effectiveness and sustainability of multidimensional modular intervention measures integrating cognitive training, physical training, and health education to an empirical test and thereby further contribute to foundational research in the field of intervention programs for an ageing workforce.

It is a particular strength of the developed modular program that it can be attuned to the specific needs and interests of employees, employee representatives and employers, to the opportunity structures and peculiarities of diverse employment relationships, working time models, job qualifications and work activities. The analyses to be presented in the following parts of the paper abstract from diversity in respective occupational contexts, since we are primarily interested in the evaluation of a comprehensive intervention concept, which can be attuned and further specified in individual cases of implementation. In this context we do not only discuss questions of effectiveness and sustainability but also – more basically – aspects of practicability which are essential for translation of intervention research into corporate planning and policy.

5. Research Methods

Practicability, effectiveness, and sustainability of the modular program were evaluated in four research projects. Initially, the idea of an interdisciplinary modular vocational training was developed in a co-operation with Robert Bosch GmbH and Robert Bosch Foundation lasting from 2007 to 2010. The first three months of this project were used for an actual state analysis on vocational trainings and development of strategies and measures to be used in later phases of intervention. The developed program

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was implemented in a pilot study with an intervention period of six month and observation of intervention effects in the following 9-month period. Since intervention measures proved to be successful against changes observed in a control group which was recruited in a similar factory located in a different region of Germany, intervention effects were further evaluated in a new intervention study with a bigger sample and a new control group – participants of the intervention group were recruited in the factory which had been chosen for recruitment of the control group in the pilot study. Overall, 105 older workers (25 women and 80 men) participated in the modular intervention program; the control group consisted of another 50 (13 women and 37 men) older workers.

In a second research project the modular intervention program was implemented in co-operation with Deutsche Bahn between 2012 and 2013. Here, a total of 261 older workers (112 women and 139 men) participated in the modular program which was implemented in three different versions. In contrast to the aforementioned research project, the different units of the program were not completed in weekly sessions following respective work shift but integrated into training days which were completed instead of regular working days. 93 participants completed the modular program within 7 working days (4 days for education and training and 3 days for testing and individual counselling), 158 completed the modular program within 5 working days (3 days for education and training and 2 days for testing and individual counselling). Control group consisted of 30 older workers (12 women and 18 men).

In a third research project the modular intervention program was implemented in co-operation with the Municipality of Heidelberg. Here, number of participants was restricted to a maximum of 150 women and men 45 years and older, with the Municipality being responsible for selection of participants. 148 participants (88 women and 66 men) completed the program in 7 working days (4 days for education and training and 3 days for testing and individual counselling). Control group consisted of another 30 older workers (15 women and 15 men).

Finally, the modular intervention program is contemporarily implemented in co-operation with the Baden-Württemberg Employers' Association for the Chemicals Industry, in two companies each year. Heretofore, 33 older workers (15 women and 18 men) from four small and medium-sized companies completed the program in 7 working days (5 days for education and training and 2 days for testing and individual counselling). Following the preferences of the companies it was abstained from recruiting controls in these projects.

Program effectiveness and sustainability were evaluated using a longitudinal research design. which consisted of three to five measurement points. All participants of the aforementioned research projects were tested at the beginning, in the middle, and at the end of the program. Additionally, all 105 participants of the first project, 93 participants of the second project, and all 148 participants of the third project were tested for assessment of sustainability of intervention effects 3 months after they had completed the modular intervention. Moreover, in the research co-operation with Robert Bosch GmbH and Robert Bosch Foundation sustainability of intervention effects was also checked in 95 of the 105 participants 6 month after completion of the modular intervention. Examination of intervention effects and sustainability proceeds from data of 110 controls who were tested at three measurement points which were comparable to the first, the third, and the fourth measurement points of the respective intervention groups (i.e. at the beginning, at the end, and 3 month after completion of the modular program).

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Concerning cognitive abilities concentrativeness, speed of information processing, inhibition, and capacity of working memory were defined as target variables of evaluation. Concentrativeness was selected as an outcome since this ability is not only reflected in the time needed for dealing with everyday tasks and challenges in occupational contexts. Moreover, concentrativeness is essential for precision in dealing with routine as well as more complex and sophisticated tasks and problems. Significance of speed of information processing does not only impact time needed for successful completion of working tasks. Moreover, simultaneous availability of interim results as a precondition for coping with more complex tasks and challenges, and applicability of prior information processing can be restricted by too-slow speed of information processing. Inhibition of distractors and nongoal path ideas is essential for the ability to focus on relevant stimuli and effective use of skills, competences, and knowledge systems. Capacity of working memory refers to the ability to handle relevant information simultaneously. Concentrativeness was measured as discrimination performance under deadline pressure using the d2 test (sum of correctly crossed-out characters, minus confusion errors; Brickenkamp et al., 2010), speed of information processing was measured using NAI-number connection test (time needed in seconds; Oswald & Fleischmann, 1999), inhibition was operationalized by color-word interferences using the stroop test (time needed for correct naming of words; Siegrist, 1997), working memory was measured with digit span subtest of WAIS (mean length of longest correctly remembered sequence of numbers forwards and backwards; Choi et al., 2014).

Evaluation of changes in physical abilities focused on physical strength, endurance, and coordination. Respective observations were coded on a 5-point rating scale. Physical strength was measured as the number of pushups and sit-ups participants were able to perform successively, with men needing a higher number for the same score. Endurance was operationalized with the 2km-walking test (monitoring heart rate and walking time; see Tittlbach et al. 2005). Coordination was measured as the time of being able to keep balance standing on one leg (right and left) with open and closed eyes.

Changes in health behavior, control beliefs and attitudes toward own ageing and overall optimism were assessed in the context of semi-structured interviews in which participants were asked for an evaluation of program participation, particularly resulting effects on own perspectives on old age, ageing, and plasticity.

6. Findings

Changes observed in the cognitive target variables in the intervention group (575 participants) and the control group (110 participants) are reported in Table 1.

Table 01. Changes in cognitive target variables

Measurement point	Concentrativeness		Speed of information processing		Inhibition		Capacity of working memory	
	IG M (SD)	CG M (SD)	IG M (SD)	CG M (SD)	IG M (SD)	CG M (SD)	IG M (SD)	CG M (SD)
Beginning of program	161.2 (35.18)	168.1 (39.45)	89.5 (21.92)	84.0 (19.22)	86.01 (18.17)	85.21 (18.17)	6.82 (3.53)	6.50 (3.00)

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End of program	178.9 (37.67)	172.6 (38.72)	74.5 (12.12)	82.0 (15.10)	75.21 (19.18)	85.00 (19.18)	8.04 (4.24)	6.32 (3.12)
3 months after end of program	174.2 (36.84)	172.0 (38.00)	77.5 (16.36)	85.1 (17.33)	74.12 (18.22)	83.12 (18.22)	7.50 (3.41)	6.61 (3.22)

Table 1 shows significant improvements ($p < .05$) for the four cognitive target variables between the two measurement points at the beginning and at the end of the modular program. These increases were slightly reduced in the 3 months following completion of intervention measures; however the latter changes did not reach statistical significance. In contrast, no significant changes were observed for the same period in the control group. To clarify practical importance of the observed changes we calculated effect sizes for changes in the four cognitive variables as a ratio of respective differences in variables between earlier and later measurement point (i.e. increases or decreases in observation period), and standard deviation for the respective variables (i.e. observed variance between participants in the intervention group) at the beginning of the intervention measure. These analyses have the advantage that changes in different variables can be compared with one another (in terms of average percentile gain). Effect sizes of 1.0 indicate, that the respective mean for the group changed by one standard deviation – e.g. a percentile gain from 50 to 84.1 or from 84.1 to 97.7, respectively. According to convention effect sizes of .20 indicate a small effect, whereas effect sizes of .50 and .80 indicate a moderate or strong effect, respectively.

Analyses of effect sizes indicate moderate to strong effects for speed of information processing and inhibition ($d= .68$, and $d= .59$), a moderate effect for concentrativeness ($d = .50$), and a small to moderate effect ($d= .34$) for capacity of working memory during the intervention period.

Observed changes in physical target variables are reported in Table 2. Again, analyses suggest significant improvements for the intervention group whereas no changes were observed in the control group. In the intervention group, average scores for endurance and coordination increased significantly ($p < .05$) between the beginning and the end of the modular program; no further significant changes occurred for the three-month period following the intervention program. In contrast, evaluation showed no significant changes for physical strength. The latter observation might be qualified by rather high initial scores for the participants (in both groups). Possible improvements might have been not detected due to ceiling effects.

Analyses of effect size indicate a moderate to strong effect for endurance ($d= .68$) and a small to moderate effect for coordination ($d= .32$) for the intervention period. Considering development of physical abilities between the beginning of the program and the measurement point 3 months after completion of the program shows a strong effect for endurance ($d= .76$) and a small to moderate effect ($d= .39$) for coordination.

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Table 02. Changes in physical target variables

Measurement point	coordination		strength		endurance	
	IG M (SD)	**CG** M (SD)	**IG** M (SD)	**CG** M (SD)	**IG** M (SD)	**CG** M (SD)
Beginning of program	2.62 (1.07)	2.45 (1.00)	2.06 (1.32)	2.00 (1.40)	3.01 (1.17)	2.88 (1.30)
End of program	2.28 (1.00)	2.35 (1,21)	2.01 (1.19)	2.16 (1.47)	2.21 (1.18)	2.75 (1.56)
3 months after end of program	2.20 (1.11)	2,39 (1,27)	2.06 (1.23)	2.13 (1.44)	2.12 (1.22)	2.66 (1.41)

Individual counselling sessions after completion of the modular program indicate that the majority of participants in the intervention group had been motivated to engage in increased self-reflection of own health behavior. 514 of the 575 participants of the intervention group (i.e. 89.4%) reported that participation resulted in heightened health consciousness, 495 (86%) stated to be now more optimistic about malleability of own ageing processes. Roughly two thirds of the participants (N= 381) said that they already had at least somehow changed health behavior (N= 201) or intend to engage in respective changes afterwards (N= 180). More specifically, changes of behavior primarily referred to physical activities (N= 155), cognitive training (N= 31) and risk factors (N= 25), intended changes of behavior primarily referred to physical activities (N= 120), risk factors (N= 67), stress management (N= 43), preventive checkup (N= 33), and cognitive training (N= 29). Three months later 365 participants (63.5%) stated that compared to the beginning of the program own health behavior had substantially improved. Information on perceived changes in control beliefs, attitudes towards own ageing, and overall optimism further support a positive evaluation of program effectiveness and sustainability. After completion of the modular program, 401 participants (69.7%) perceived ageing processes as more controllable, 382 (66.4%) said their attitude towards own ageing had become more positive, 363 (63.1%) perceived themselves as increased overall optimistic than in the beginning. Proceeding from information obtained three month after the end of the program, the aforementioned attitude changes somehow decreased in after participation but nevertheless are sustainable majority of the sample. Here, 342 (59,5%) reported a still more positive attitude towards own ageing, 313 (54.4%) reported higher controllability, and 291 (50.6%) reported increased overall optimism.

7. Conclusion

A final evaluation of the modular program proceeds from two complementary components of analysis: an objective analysis component comprising findings on change in cognitive and physical abilities, and a subjective analysis component considering participants' perspectives on lasting effects of the modular intervention program. Both components coincide in accentuating positive effects resulting from participation in the program, and sustainability. Longitudinal assessment of speed of information processing, inhibition, concentrativeness, and working memory capacity indicate sustainability of improvement, calculation of effect sizes shows that the respective effects are not only statistically significant but also practically important. Effects observed in physical abilities are somewhat smaller, but

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nevertheless statistically significant and practically important. Likewise, results of the evaluation show sustainability of effects in physical abilities. Three months after completion of the program, effects in physical abilities are even stronger than three months before, suggesting that a substantial number of participants indeed changed health behavior and continued physical training after the end of the program.

The subjective analysis component notably confirms the positive effects of the program. Participants not only evaluated the contents, preparation and implementation of the intervention very positively. Also noteworthy is that in counselling sessions, participants regularly referred to perceived increases in self-regulatory competences and already completed and planned change in health behavior. Interviews further suggest that participants' motivation to engage in self-regulatory behavior is not restricted to the area of mental and physical health. The subjective analysis component further indicates that perceived control potential and overall optimism substantially increased, attitudes towards own ageing likewise became more positive. These observations led us to the assumption that the program also made a significant contribution to active aging.

From the experience we have gained over the course of the four research projects, it can be concluded that also the employers - and not only the participants - benefit considerably from the program. On the one hand, due to increasing achievement motivation and loyalty with the employer, on the other hand by the fact that in the long-term participants invest more in the maintenance of cognitive and physical performance as well as in the maintenance of health. As a result, employability should develop more favorable over the working life.

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Corresponding Author: Jörg Hinner
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