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ABSTRACTS

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Physical Activity and successful aging: Keynote lectures

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Healthy mind in a healthy body? A review of sensorimotor-cognitive interdependencies in old age

U. Lindenberger

Normal aging is associated with losses in the functional integrity of sensory, sensorimotor, and cognitive domains. Each of these losses has been studied extensively at behavioral and physiological levels of analysis. Recently, the questions whether senescent changes are causally shared and functionally coupled across domains, and malleable through experience have received increasing attention. I will review evidence regarding causal and functional couplings between sensorimotor and cognitive aging, with a special emphasis on potential ways to improve the course of cognitive aging through sensorimotor intervention. Reported evidence will include correlational studies, dual-task experiments, and aerobic fitness interventions, as well select neuroscience work in animals and humans. First, correlational cross-sectional and longitudinal data indicate increasing associations between sensorimotor and cognitive aspects of behavior with advancing age.

Second, older adults show greater performance decrements than young adults when sensorimotor and cognitive tasks or task components are performed concurrently rather than in isolation. Third, aerobic fitness interventions produce positive transfer effects on cognition that are particularly pronounced for tasks with high demands on attention and executive control. Fourth, neuroscience findings from animal models and humans have identified aging-sensitive structural and functional circuitries that support cognitive functions and are enhanced by higher levels of sensorimotor functioning. I conclude that sensorimotor and cognitive aging are causally related and functionally interdependent, and that age-associated increments in cognitive resource demands of sensorimotor functioning are malleable by experience.

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Skeletal muscle and aging

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Biological aging can consists of the progressive decline in body function with chronological age that predisposes individuals to the occurrence of diseases and to an increased risk of death. This eventual impairment of functionality is influenced by genetic and environmental factors and can be explained by a continuous loss of redundancy in organic systems, which results from the imbalance between the rate of cell death induced by physiological or pathological events and the rate of cellular repair. Depending on multiple genetic and environmental factors, the aging process shows a high interindividual variability. Beyond its overall effects on the entire organism, this process seems to affect various organs at

different intensities. It is moreover assumed that aging of one organ or system may negatively influence the function of other organs thereby extrinsically accelerating their degeneration with age. Such interdependence becomes more apparent with the age in this sense of a vicious circle. Also diseases with local or systemic repercussions may enhance the rate of local and systemic degenerative processes thus contributing to an acceleration of the aging process. Such would favour the occurrence of additional cellular damage that in turns favours the incidence of organ failure. Therefore, any progress in the aging process is exponential and becomes apparent when the rate and efficiency of regenerative mechanisms are overwhelmed by the rate of cellular and tissue degeneration.

Considering skeletal muscle, the capacity to perform mechanical work is most affected with the enhancement of chronological age. Tissue oxidation and glycosilation are the intrinsic mechanisms classically associated with the severity of damage in skeletal muscle with age. Moreover, aging of skeletal muscle system may also accelerate the degenerative processes of other organs either by consequent disuse or by negative biomechanical effects. For instance, the interdependence of osteoarthritis and alterations of periarticular muscles is known and it is suggested that a weak quadriceps muscle cannot produce enough force to stabilize the knee and to prevent it from overload during the amortization of the mechanical impact during gait. Concerning the hip joint, recent data also support the concept that atrophy of abductor muscles should be of etiological importance for the development of contralateral hip osteoarthritis.

The function of skeletal muscle intimately depends on the central and peripheral nervous system, which controls muscle trophism and fibre type properties by regulating muscle gene expression. These neural effects on skeletal muscle involve two distinct mechanisms: a humoral mechanism mediated by the release of neural factors from the nerve terminals, and a neurophysiological mechanism mediated by the pattern of electrical nerve discharge. Interestingly, the degenerative morphological alterations observed in skeletal muscle with age strongly coincide with a chronic neuropathic process. The most evident change is a decrease in the total number of motor units.

Loss of motor units not accompanied by an equal loss of muscle fibres suggests that each motor neuron innervates more muscle fibres in the aged than in younger muscles. These results are in accordance with the phenomenon of fibre type grouping and suggest an early preferential degeneration of the fast motor units with age. Considering all the above referred findings, it is suggested that skeletal muscle morphological and functional alterations with age do not only result from intrinsic factors within the muscle fibers but are mainly influenced by aging phenomena of the nervous system, especially of its peripheral components. In this sense, the alterations found in muscle fibres represent secondary effects based on the aging process of the nervous system. This concept should not only be useful to explain eventual losses in strength encountered at advanced ages, but should also explain the increased inability of elderly subjects to properly perform simple tasks of daily life. A loss of motor units and concomitantly larger motor units in general leads to an impaired coordination. Assuming that aged skeletal muscle has a reduced adaptive potential, due to a diminished number and reduced proliferative capacity of satellite cells, it can be assumed that the benefits of physical activity in the aged muscle, particularly observed after strength training, are mainly due to neural adaptations which might retard or prevent the consequences of the aging process primarily at the level of the nervous system, with beneficial secondary effects on the functional properties of skeletal muscle.

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Preventing falls in older people? The role of exercise

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Falls amongst older people are common, and the risk of falling increases with age. Although only a minority of falls result in serious physical injury, the consequences of falls have a major impact on both health and social care budgets. The last decade has seen a burgeoning of good quality evidence on how to prevent falls. As the risk of an individual falling is multifactorial, then intervening against multiple risk factors is conceptually attractive, and the evidence for the effectiveness of such an approach is good. Effective prevention involves identifying and modifying, where possible, risk factors for falls. Common modifiable risk factors include muscle weakness, problems with balance gait or stability, multiple drug therapy, postural hypotension, and cardiac disorders.

As muscle weakness and postural instability underlie many falls in older people, there has been much research activity assessing the potential that exercise might reduce

falls. The role of exercise in fall prevention has been the source of much confusion and misunderstanding. This is because it is often forgotten that the effect of any exercise is specific to the type of exercise being undertaken.

Accordingly, it has become clear that only a very highly specific type of exercise is effective in preventing falls: individually tailored, home based, one-to-one, professionally prescribed, progressive muscle strengthening and balance retraining combined with a walking plan [1, 2]. General exercise programmes, including seated exercise have not been shown to be effective in reducing falls.

Clinical trials report only modest reductions in falls, usually less that 35% in the number of people falling and in the number of falls [3]. While this is a worthwhile reduction, some falls in older people are not preventable. In our enthusiasm to reduce falls, we must ensure that the autonomy of old people is not compromised. Older people should be encouraged to walk and be active and take reasonable risks. After all a risk-free life is no life at all.

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Successful aging: a perspective from lifespan psychology

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People have long sought after the fountain of youth, looking for ways to live longer and to improve the quality of life. Not only are people now living longer than in the earlier part of the twentieth century, the quality of life is also improving. What factors contribute to a successful later life? To answer this question we first need to define what successful means. Depending on whether objective or subjective criteria are used some predictors of successful aging differ and others overlap. When it comes to objective indicators such as longevity, health, or cognitive performance, research has shown that lifestyle choices seem to be crucial. Some of the psychosocial factors and behavioral factors are exercise, healthy diet, sense of efficacy and control, mental stimulation, and social support. When focussing on subjective criteria such as subjective well-being, a rich array of self-regulatory mechanisms but also social context characteristics have been identified. An integrating discussion of findings on successful aging from a lifespan perspective is offered.

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Physical Activity and successful aging: Selected contributions

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Individually tailored programs in a nursing home setting

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Objective

A Norwegian research group in Oslo was invited by Kerstin Frändin to take part in the study "Physical and daily activities for residents in a nursing home setting-a multi-center-study".

Objectives

To describe the impact of an individually tailored intervention program, in a nursing home setting, on physical capacity, dependence in Activities of Daily Living (ADL) and wellbeing.

Methods

Oslo recruited 56 persons who are randomized to either intervention (I) or control (C). Both groups are tested at baseline, after three months of intervention and finally after another three months. Muscle strength, walking (or wheelchair propulsion) speed, balance, ADL, wellbeing and cognitive function are used as outcome variables. There were no significant differences at the baseline regarding gender, age, physical capacity, dependences in ADL and wellbeing between I and C. An individual intervention program, designed by physical and occupational therapists in accordance with the goal of each participant, is formed. Examples of activities (intervention), performed by trained physical and occupational therapists are:

1. Evaluation of each subject leading to an individual goal setting and a training programme.
2. Training of transfers and walking ability, balance, muscle strength and endurance.
3. ADL-training: Personal care and dressing procedures, eating and socialising. Assistive devices are provided if needed.
4. Daily activities: Based on personal interests each client is being invited to participate in creative and/or entertaining activities like art, music, gardening, cooking and baking.

Results

Baseline data from 56 subjects in Oslo (76,8% women), showed a mean stay at nursing home of 30 months (range 2–178) and a mean Mini Mental State Examination score (MMSE) of 23.6. Seventy-five percent could walk with or without walking aids. Seventy-one percent were able to stand up from a sited position without help. Men had a significant higher grip strength, lower age and lower score on the Functional Independence Measure (FIM) compared to women at baseline. No ceiling or floor effect of the instruments of muscle strength, walking, balance, ADL, wellbeing, or cognitive. We found a significant increased score of Berg's Balance Scale and walking speed in the I-group after the intervention period compared with the C-group. No long-term was observed.

Conclusions

Data show a tendency of greater improvement and maintenance of function in the intervention group. It can be demonstrated, that individually tailored programs with the purpose to increase the level of physical and daily activities lead to a significant improvement of balance and walking.

However no longterm effect was observed.

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"Miniature golf comes to you"-interventions for elderly people in Vienna's "Homes for Living"

R. Diketmüller

For elderly people in residential homes, the barriers to engage in physical activity and sports are very high. To activate a highly physically inactive group the consideration of sport-geragogic aspects and health-enhancing implications, which target individual, community and the environmental levels, is necessary. An important factor in motivating the elderly for physical activities is that the offers have to suit the specific living circumstances and needs and that the entrance barriers are very low. The project 'Miniature golf comes to you' addresses the elderly living in Vienna's 'homes for living' and offers the possibility to experience indoor miniature golf with mobile courses, variable obstacles and a specific mechanism to pick up the ball. In a championship, persons from different apartment houses compete with persons from other houses in individual or team-competitions. Since the start of the project in 2002, more than 200 older persons regularly participated in this tournament. The main aim of this study was to evaluate this activation program and to ascertain the reasons for its wide acceptance and success. Furthermore, the question was raised as to which effects these moderate physical activities have on health and activities of daily living.

To evaluate the program, questionnaires and interviews with the participants, interviews with the organizers and the contact persons of the residential homes and participant observation were applied.

The results show that the project 'miniature golf comes to you' complies ideally with the requirements of the elderly. It inspires very old persons as well as handicapped persons and persons, who were never sporty before. The participants - and

also frail ones - have begun again to step out of their homes regularly to engage in the competition or to visit other teams for a common training, for example. Considering the high number of very old and partly frail persons in this activation program, the number and quality of those activities, which are necessary to stay mobile, to sustain social contacts and to participate in public activities, is highly remarkable and shows the high health-enhancing relevance of this project.

The findings lead to the assumption that elderly seem to benefit as well from the surrounding demands of the participation in the tournament (mobility to reach the site of competition, activity to stay in contact with other people or to organize training teams, competence and creativity to arrange training facilities, ...) as from miniature golf itself. Even the fact that this competition is organised as an indoor event in a protected area and embedded in traditional daily social routine, the reported status of well-being of the participants is very high. Especially the design, its included principles of sport-geragogic aspects with its consideration to the needs of the elderly makes the project 'Minigolf comes to you' so effective and a model of good practice for further activity programs for the least active segment, the oldest old.

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Detection and anticipation of multiple dynamic objects-special problems for elderly?

A.O. Effenberg • B. Dierke

Objective

Complex situations are often characterized by special constellations of multiple dynamic objects, in city traffic as well as in a number of team games in sports. To act successfully within such complex scenarios it is necessary to detect multiple dynamic objects nearly simultaneously. Beside object- detection also specification of detected objects (anticipation) is essential for action planning. The contribution focuses on a new computer-based visualization-test called 'DAMDO' which is created to test the ability of 'Detection and Anticipation of Multiple Dynamic Objects'. Beside the test itself empirical data will be presented acquired for different age groups and for 4 vs. 8 dynamic object-constellations as well as different typs of scenarios: static collision-condition vs. interactive collision-condition.

Methods

A virtual space containing 4 or 8 dynamic objects (rolling balls of different colours) is created with '3D Game Studio 6'-Software and presented on a 21″ computer-monitor. Different speeds (constant) of balls had been oriented on typical values for city traffic and sports: 5, 15, 30 and 50 kilometers per hour. Two different typs of scenarios had been realized: (1) Static collision- condition: One of the rolling balls collides with a static pylon at the centre of the space, and (2) interactive collison-condition: Two rolling balls bang together anywhere within the space.

Subjects

(20–40-year old, 60+-year old) sat in front of the monitor with eyes 75 cm distant to the screen and were asked to stop animation with identification of colliding ball(s) immediately. Screen was getting black, time was taken and subjects have to name the color of the colliding ball(s). Time as well as errors had been analysed.

Results

Significant differences had been detected for different age groups, different collision-conditions and different numbers of objects. Older people needed more time and made more mistakes. On 4 objects scenarios (static condition) error rate was nearly identical for both age groups (20–40: 1.34 vs. 60+: 1.41) but time to decision ('costs') was significantly .41 sec longer for 60+. On 8 objects scenarios (static condition) costs increased nearly identical for both age groups, but error rate for 20–40-year old remained constantly whereas it nearly doubled for 60+-year-old subjects.

Conclusion

Costs for a larger number of dynamic objects increased as well as for the interactive collision- condition. For older

people especially interactive collision-condition seemed to be problematic. Further research is needed to investigate if training in team games in sports enhances the ability of detecting and anticipating multiple dynamic objects.

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Training effects on gait parameters during obstacle negotiation in Parkinson's disease patients: preliminary data

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Parkinson's disease (PD) patients present difficulties in performing sequential tasks such as walking and stepping over an obstacle. However, the influence of regular practice of physical activities on the gait parameters over uneven terrain is less known.

Objective

The aim of this study was to verify the effects of a training program on the gait parameters of the adaptive step over the obstacle.

Methods

Twenty-nine patients with idiopathic PD (18 men and 11 women; 66.8+8.2 year-old; severity stages from 1 to 3 by Hoehn and Yahr Scale) were selected for participation in the study. Spatial parameters of gait while stepping over the obstacle were collected by a digital camcorder at 60 Hz.

Passive markers were attached at the fifth metatarsal, calcaneus, and lateral malleolus of right limb (leading limb) and first metatarsal, calcaneus, and medial malleolus of the left limb (trailing limb).

Participants were invited to walk and step over each one of two personalized obstacles (mid shank and ankle height) that were placed on the middle of a 10 m long and 1.4 m wide pathway, during 5 trials per condition. This gait protocol was carried out before and after the training program.

Fifteen patients have already completed 50 sessions of training that comprised activities equally distributed of resistive training, balance, and locomotion over uneven terrain across the University campus. The following dependent variables were collected at the adaptive step over the obstacle: leading and trailing foot placement before the obstacle; leading and trailing toe clearance; and leading foot placement after the obstacle crossing. Analyses have demanded a significant amount of work on the images (Dvideow 5.1 software) and then we have already finished the data analyses from four patients (total of 80 trials). Repeated measures ANOVA (2 obstacles and 2 training moments) by trial and for each dependent variable was used to verify the influence of obstacle height and training program on gait parameters during obstacle negotiation.

Results

The results revealed that obstacle height did not affect any of the adaptive gait parameters. On the other way, the training program exerts large influence on all gait measures. PD patients increased the leading and trailing foot placement before the obstacle ($F(1.38)=9.742$, $p<0.004$; $F(1.38)=4.632$, $p<0.039$; respectively), the safety margin over the obstacle for both limbs ($F(1.38)=29.881$, $p<0.001$; $F(1.38)=9.764$, $p<0.004$; respectively), and the leading foot placement after the obstacle crossing ($F(1.38)=8.527$, $p<0.007$).

Conclusion

These results revealed a trend in the way that the practice of physical activities in a specific training program comprising activities designed to develop strength, balance, and locomotion can improve the gait parameters during obstacle negotiation, in older people with Parkinson's disease.

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Fall reduction 60% with the "In Balance" programme

G. Kroes

Objective

Falls in the aging population pose a major threat to indepence, and to quality of life in the elderly.

Falls in the elderly are a major health concern due to the financial impact on the public health care system.

In the year 2000, the Netherlands Institute for Sports and Physical Activity did make a start of developing a fall prevention programme based on the therapeutic elements of T'ai Chi, that have been identified as most benificial for elderly persons.

The reason to start this project is that a lot of pre-frail and frail persons, who don't reach the Pate norm (30 minutes a day of moderately intensive physical activity for a minimum of five days a week) answer that there bodily complaints hinder them to be active and that there is a lack of self-conficence (a fear of falling). However these are important reasons that the risks of falls increase.

Realization

But how to locate this people and how to stimulate them to be more physical active? We designed a programme with a low psychological treshold. We built a three phases system; the elderly can choose or they will continue their participation after every phase:

- Phase one: introduction meeting about the aim of the programme, information and questions (lasting 2 hours).
- Phase two: awareness: one session lasted half a day per week during four weeks. Content: the causes of falls, a risk-screening, a balance-test and an exercise grouptraining.
- Phase three: training: twice weekly sessions during 16 weeks with attention to: condition, balance, muscle-strength, Tai Chi elements.

After the programme: continuation in regular local exercise groups with permanent attention of balance-exercises.

Experiences

The Free University in Amsterdam (Faber and others, 2005) did a 20-week, multi-center randomized controlled trial in 15 homes for the elderly with 278 participants with a mean age of 85 years. Positive effects of the programme became apparent after 11 weeks of exercise. The programme did not use exercises with a maximum reach of intensity. The power of the programme is to create a situation that can be incorporated into daily life. The "In Balance" moderate intensive group-excercise programme has positive effects on falling and physical performance in pre-frail elderly and can rise till over the 60%.

Conclusion

The conclusion is that the high score of fall reduction compared to the effects of other effective interventions is highly promising. 85% of the participant will continue the programme, 50% once a week and 35% twice.

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The effectiveness of a home-based exercise for older Portuguese people

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Objectives

The majority of Portuguese older people are not motivated to do physical activity. Home-based exercise programmes are thought to be ideal for this population.

The aim of this study is to assess the effectiveness of a moderate, specific, home-based exercise programme, without any equipment, on falls risk factors (muscle endurance, flexibility, lower limb strength, balance and voluntary stepping time), quality of life and participation, in elderly Portuguese people.

Methods

60 older people volunteered from Oporto Health Center and were randomized into an intervention (n=26) or a control group (n=34). Sit to Stand test (STST), Timed Up and Go (TUG), Functional Reach Test (FRT), Lateral Reach Test (LRT), Voluntary Stepping Time Test (VTST) stepping forward with right and left foot (SFRF and SFLF respectively), stepping laterally with right and left foot (SLRF and SLLF respectively), and stepping backwards with right and left foot (SBRF and SBLF respectively), Active Range of Movement (AROM) in both ankles, Index of Kyphosis (IK), Falls Efficacy Scale (FES), Quality of Life of the Old Person (QoLOP) and Functional Status Questionnaire (FSQ) were assessed at baseline and after 3 months.

Inclusion criteria: between 65 to 84 years old, functionally independent in the community, able to walk without walking aids.

Participants with lower extremity amputation, neurological disease, severe musculoskeletal disease, Folstein Mental Status score <15, unstable cardiovascular disease, and blindness were excluded.

The intervention group undertook a moderate, specific, home- based exercise programme for 3 months and the control group continued their normal activities.

The exercise programme consisted of 10 exercises. The first five, which were undertaken in sitting, involved cervical retraction, cervical rotation, thoracic extension, shoulder elevation, and ankle joint dorsi and plantar flexion. The remaining exercises were one leg stance, forward and lateral reach, rapid stepping in all directions, and walking. The exercises were progressed through increased repetitions, changing body position, increased speed, and increased distance reached and walked.

Results

Participants in the intervention group had improved in the majority of the outcome measures: STST ($F=26$, $p=0.0001$), TUG ($F=8.8$, $p=0.04$), FRF ($F=9.0$, $p=0.004$), SFRF ($F=14.6$, $p=0.0003$), SFLF ($F=17.5$, $p=0.0001$), SLRF($F=8.0$, $p=0.007$), SLLF($F=18.5$, $p=0.0001$), SBRF ($F=9.9$, $p=0.003$), SBLF($F=13.2$, $p=0.0006$) and Instrumental Activities of Daily Living (IADL) in FSQ ($F=5.6$, $p=0.02$) compared with the control group. No change was seen in FRL, IK, FES, QoLOP, Activities of Daily Living, Emotional and Social dimensions of FSQ as a result of the intervention. Adherence to the programme at 3 months was 79%.

Conclusion

A moderate, specific, home-based exercise programme, easy to administer and to undertake by the participants, improved fall risk factors and participation in Portuguese old persons.

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