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MOTOR LEARNING FOR AGEING: AN INNOVATIVE DIGITAL APPROACH

APPRENDIMENTO MOTORIO PER ANZIANI: UN INNOVATIVO APPROCCIO DIGITALE

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Abstract

It is widely accepted that physical activity, undertaken as a combination of aerobic, strength and balance exercise, has a key role in the reduction of overall age- related decline. For years now, also due to pandemic restrictions several distance exercises for elderly have been suggested. Elderly must face an inevitable physical decline and an increasing cognitive and learning limitation due to aging. This requires a global motor learning approach that goes beyond the mere segmental execution and lets the older senses the own body perception with the aim to learn motor skills in a renewed modality, adapted to ageing limitations. Thus, there is a need to design an educational system dedicated to older people for remote exercise by means of a smartphone application. On this basis, the proposed intervention aims to educate elderly to build global movements through an innovative perspective based on the segmentary perception of the body during exercise with the aid of a smartphone.

È ampiamente riconosciuto che l'attività fisica, intesa come combinazione di esercizi aerobici, di forza e di equilibrio, giochi un ruolo importante nel contrastare il fisiologico declino motorio e cognitivo nell'età adulta e anziana. Da anni ormai, in particolare in seguito alle restrizioni legate all'evento

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pandemico sa Sars-Cov2, la proposta di esercizi da poter compiere in autonomia, e a distanza, si è arricchita anche per la popolazione attiva anziana. dove la richiesta motoria non può prescindere da un approccio all' apprendimento motorio che vada oltre la mera esecuzione segmentale ma che permetta, invece, una organizzazione del movimento del corpo nella sua globalità, con l'obiettivo di ri-apprendere le abilità motorie in una modalità adattata a questa fase della vita. È quindi necessario progettare un sistema educativo all'attività fisica che sia dedicato agli anziani, anche per l'esercizio a distanza. Su queste basi, il nostro lavoro si propone di costruire un sistema di esercizi che possa essere gestito in autonomia, tramite un'applicazione per smartphone, e che guidi gli anziani a costruire movimenti dal segmentale al globale, con una progressione crescente in difficoltà e con un monitoraggio continuo.

Key-words

Ageing - Physical Activity - Senescence - Smartphone Application
Invecchiamento - Attività Fisica - Senescenza - Applicazione Smartphone

Introduction

Senescence is a physiological process linked to morphological and functional modification of the human body due to aging (Kandel, Schwartz, & Jessell, 2000). It is caused, mainly, by two processes, the first is the increasing in DNA duplication, which occurs with a higher and higher frequency during ageing leading to an accumulation of aberrant mRNA and proteins. It seems that the cell can divide only a limited number of times. Moreover, an aged cell has a reduced number of duplications than a younger cell. These lead to a gradual loss of neurons both in the central and peripheral nervous system (Kandel et al., 2000): the changes in the central nervous system cause a mild but progressive decline in memory and cognitive abilities in elderly. In the periphery, the death of the α - motor neuron causes the de-innervation of the relative muscle fibres. However, these muscle fibres may be re-innervated by the sprouting of an axon of a surviving motor neuron. Thanks to the reinnervation process, sarcopenia (Agosti & Di Palma, 2020) does not occur before 75-80 years old (Cogliati et al., 2019; Jesunathadas, Marmon, Gibb, & Enoka, 2010). Nevertheless, the formation of bigger but slower motor units makes elderly less fast and precise in movement execution and this is evident in daily life activity (Cogliati et al., 2019). However, in normal conditions senescence does not significantly impair the quality of life, but inactivity is responsible for an acceleration of the process that can rapidly affect the efficiency and safety of daily life activity and strongly reduce physical fitness (Cunningham, O' Sullivan, Caserotti, & Tully, 2020). It is well known that, in addition to reducing senescence, physical activity plays a key role in the prevention of non-communicable disease, and it could be a powerful tool to improve the quality of life of children, adults, and older adults (Warburton, Nicol, & Bredin, 2006). World Health Organization (WHO) guidelines suggest undertaking a combination of aerobic and strength activity to maximise the outcomes of physical fitness in all these three categories. In the particular case of elderly, at least 150 minutes of moderate (3 - 5.9 MET) or 75 minutes of vigorous (> 6 MET) physical activity, or a combination of both are recommended. (Bull et al., 2020), at least two days a week, to foster improving in strength and balance. Moreover, elderly should drastically reduce the time spent sited (Arem & Matthews, 2018; Bull et al., 2020; Dunstan et al., 2012; Ekelund, 2018; Owen, Healy, Matthews, & Dunstan, 2010). Due to COVID-19 pandemic restriction,

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older people severely reduced the amount of physical activity (Castañeda-Babarro, Coca, Arbillaga-Etxarri, & Gutiérrez-Santamaría, 2020), and increased their sedentary behaviour, with harmful consequences for the physical fitness.(Ekelund et al., 2016, 2019; Hadgraft et al., 2020; Jefferis et al., 2018). However, WHO (Bull et al., 2020) suggests the quantity and the intensity of the physical activity but does not encompass the modality of physical activity administration. For this reason, a dedicated approach is needed to optimise the effect of the physical activity. The aim of this pilot study is to propose, with the aid of a digital platform, a dedicated approach to optimise the effect of physical activity in elderly. It has been developed 1) a lifelong learning based educational strength and balance intervention; 2) a talk test to maximise the outcome of the long-distance walk and an improved evaluation model to assess fatigue during and after aerobic physical activity; 3) a renewed assessment of the physical activity enjoyment.

1. Walking and talk test

Walking is the most practised physical activity in the world, by people of every age or sex, with different aims: it can be used to move for daily life errands, to train or just to enjoy the leisure time and could be carried out as light, moderate or even vigorous intensity (Hall, Howe, Rana, Martin, & Morey, 2013). Therefore, sitting time can be interrupted by a walk so as practising light-physical activity instead of being seated has a positive effect on health, e.g. it ameliorates cardiometabolic health in post-prandial time and reducing glucose and insulin levels (Bailey & Locke, 2015; Dunstan et al., 2012). Furthermore, walking is usually undertaken outside allowing both to exercise and to spend time in the green areas of the cities, as well in active mobility for leisure, errands, and other duties (Borgogni & Farinella, 2017; Cudicio et al., 2019) also, with positive effect on mental health. Evidence highlights that people who normally walk outdoors improve happiness and self-esteem and reduce anxiety and depression (Kelly et al., 2018) and this is crucial in populations more exposed to mental health diseases such as elderly. Choosing the proper walking intensity can help to protract physical activity in time (Alloatti et al., 2012). Too low intensity could be less effective on physical fitness, on the other hand vigorous exercise can determine the interruption of the activity. A moderate walking pace could guarantee a safe and effective exercise aimed to respect the amount of time spent for physical activity recommended by WHO. In general, a good walking pace should be between 4 and 7 km/h that corresponds respectively to 3 and 6 MET that are the minimum and the maximum equivalent of the task to keep the activity in a range of moderate intensity. However, the intensity of the effort depends on the physical fitness level and on the age of the walker (Kujala et al., 2017). For this reason, to recommend the proper intensity is a tough mission. Physiological parameters (i.e., gas exchange with the ambient or heart rate) can be recorded to precisely describe the intensity but metabolimeter and heart rate monitor are expensive, bulky and most of the time not user friendly. It is necessary to employ a practical and inexpensive tool to quickly measure the intensity of the effort during a walk. The talk test (Reed & Pipe, 2014) can be used by anyone and is easy to use. This test simply consists of speaking during the walk. Once the talk is not fluent anymore and conversational speech is not comfortable, this means that the ventilation is raised, and it is due to the increasing of the exercise intensity. At this point, the exercise reached 50-75% of VO_2max that is equivalent to the ventilatory threshold. This test is quite helpful for the elderly that can simply

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self-evaluate the effort with a practical tool. With the aid of a smartphone application (APP), it is possible to administer the test during the walk. A notification will appear on the screen and the elderly should utter a simple sentence. The APP will recognize any excessive intensity sign analysing the speed of the speech, the cadence of the words and the time elapsed between the words. If necessary, the APP can give a hint to the user to self-regulate the intensity of the walk, instantaneously optimise the effectiveness of the exercise. Moreover, data collected during the walk will be integrated with the results of the fatigue test in order to give feedback for the next walks.

2. Fatigue assessment

Fatigue is described as the decrease in physical activity performance associated with the perception of difficulty in task execution (Boyas & Guével, 2011). It is divided into two components, central fatigue and peripheral. Central fatigue is mainly due to biochemical modifications in the central nervous system (Ament & Verkerke, 2009). The excitatory system is compromised, and the muscles are not activated in an efficient modality. Furthermore, arousal, motivation, attention, tolerance to discomfort, and sensitivity to stress seems to modify the perception of fatigue. In the particular case of the open loop exercise, where the individual carries out activity without any limit of time or distance, the decision to terminate the physical activity is determined subjectively and it is strongly influenced by cognitive processes. It is an everyday experience, to live a particular task, exercise or activity with undue fatigue imputable to a thought day at work or past stressing situations. This underlines the relevance of the cognitive influence on the possibility to carry out activity for a long time and the necessity to measure fatigue not only with objective tests. Self-awareness is a crucial step to increase and improve physical activity in the life of older adults (Franco et al., 2015). Peripheral fatigue is due to changes at or distal to the neuromuscular junction and in particular, to modification in the intracellular environment or within the muscular fibre (Gandevia, 2001). Task failure is due to the impossibility of the neuromuscular system to further prolong the execution of the activity (Ament & Verkerke, 2009). When the motivation of the individual is strong, the exercise could be performed with a too high and not appropriate intensity. Even if rising intensity of the physical activity could be considered a good practice, from time to time it is counterproductive; the over-exercising can produce unexpected fatigue and it may lead to abandoning physical activity. The abandonment of physical activity is a very negative behaviour that this physical activity proposal aimed to counteract. In literature it is possible to identify different methodology to assess fatigue, Borg, OMNI or VAS scales are the most common (Andersen, 2005; Borg, 1970, 1998; Close, Ashton, Cable, Doran, & MacLaren, 2004; Guidetti, Sgadari, et al., 2011; Robertson et al., 2005, 2004, 2003; Utter et al., 2004). VAS and Borg scales have some limitations: VAS is a visual scale that utilises coloured feedback that goes from red to green. The result of this test can be influenced by the subjective perception of the colour. This can give place to bias drove by emotional response. Borg scale goes from 6 to 20 and it is not extremely intuitive, and the result can be affected by the wrong comprehension of the subject. On the other hand, OMNI scale merging a numerical response range 0-10 with a visually discernible exertional formats an intuitive test also rapidly administered. It does not need a complex period of training indeed and, thanks to its graphical support, can be easily administered to persons with an initial cognitive decline such as elderly. The test will be

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proposed in Italian since the validity of the OMNI scale has been validate for Italian speaker (Guidetti, Broccatelli, et al., 2011).

3. Balance and strength exercise

Quality of life is strongly related to the capabilities to carry out daily life activities efficiently and safety. Strength and balance play a key role in the efficiency and safety of movement and their training counteract the negative effects due to ageing (Fragala et al., 2019; Lesinski et al., 2015). In our study, choosing internationally validated exercises (NIH, 2020), the main idea is to propose, by means of commented and interactive pictures, exercises moving from analytical to global practice with the objective to re-learn a daily life activity movement in an efficient and safe manner. Exercises are proposed with the aid of commented and interactive picture. The user will have the possibility to obtain detailed information about the articular segments directly involved in the activity and about the relations with the body overall. The WHO clearly explains the dose of physical activity but does not draw attention on the administration modality of these activities. Elderly needs an adapted approach that prefers a lifelong learning setup (Narushima, Liu, & Diestelkamp, 2018), the WHO are clear with respect to the quantity but do not refer to the method (modality) of proposing the exercises. Instead, our methodology highlights the importance of coordination of all the parts of the body to build a correct and functional movement, leading from a segmental to a global execution. In detail, the exercises are divided into three areas: strength, mobility, and balance. In every area the activities are classified by their difficulty level: easy, suitable for all; medium, for the persons that can easily carry out the "easy" exercises; and hard, that is the final destination of the proposed activity. The focus is on the whole body, embracing the strength and balance exercise in a coordinated gesture where cognitive (attentional) processes have a key role.

4. Enjoy physical activity

The practice of physical activity has positive outcomes not only under a physiological point of view but even on the mood and some psychological aspects. People involved in regular physical activity enjoy more everyday activity consequently the quality of life (Marker, Steele, Psychology, & 2018, n.d.; Puciato, Borysiuk, & Rozpara, 2017; Vagetti et al., 2014). The enjoyment of physical activity is fundamental to prevent a reducing in participation and/or promote of sedentary behaviour. The procedure to assess physical activity enjoyment is immediate and easy, for this reason it should be administered periodically to evaluate the quality of proposal Physical Activity Enjoyment Scale (PACES) is the most commonly used questionnaire to assess physical activity enjoyment (Carraro, 2014; Kendzierski & DeCarlo, 1991; Mullen et al., 2011). Originally this test consisted of 18 questions that required an answer on a Likert scale (1-5) where 1 corresponds to "completely disagree" and 5 to "completely agree". The questionnaire has been translated and validated both in Italian and for older people (Carraro, 2014; Kendzierski & DeCarlo, 1991; Mullen et al., 2011). A renewed PACES-it-8 items will be proposed to assess physical activity enjoyment before, during and at the end of the experimental protocol (Carraro, 2014; Kendzierski & DeCarlo, 1991; Mullen et al., 2011).

5. Planned procedure

Here we present the planning of the pilot project that will carried out in the context of SCC Innovation Hub & Living Lab Network. The pilot will include an existing group already involved by SCC-Hub composed by 20 Italian older people (Age range = 65-80, Female = 10).

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The elderly will be asked to participate in the following protocol for 6 weeks: 3 times a week long-distance walking (50 min); 2 times a week strength and balance intervention, according to WHO recommendations (Bull et al., 2020). Participants will use a dedicated APP that collects data through simple tests and questionnaires. Moreover, this application will offer several exercises for balance and strength improving. In detail, during the walk: the subject will receive a few notifications that ask to speak with the smartphone. The features of the flow speech will be evaluated instantly, and feedback will be delivered to the user. Data collected with the talk test will be elaborated with those collected with the OMNI scale. OMNI scale will be used during and after the walk; even in this case the application will show a notification on the smartphone of the user with an intuitive scale for the self-evaluation of fatigue; during the strength and balance exercises: the user could use the application to self-correct the position of the segmental parts of the body to gradually build a global movement with a lifelong learning approach. Before, in the middle and at the end of the experimental period PACES-8-it will be proposed to assess modification in physical activity enjoyment.

Conclusions

The use of smartphone and dedicated APP is a good practice in promoting physical activities participation in elderly (Ciccarelli, Borgogni, & Capelli, 2016). While the smartphone is not modifiable, the APP constitute an editable factor which should be thought out and organized like a "online" guide for older adults "while" they are performing the required amount of physical activity at a proper intensity. The modality of the proposal in our work, which looks in this direction, the user will be educated, through the guide in perception of the segmentary position of their own body, learning a global movement, useful for everyday life activity. The intensity of the walk will be regulated, to moderate (3-6 MET), with the aid of the talk test. This permits to carry out the exercise without excessive fatigue throughout the entire exercise. Moreover, a new graphical and intuitive OMNI scale has been designed in order to assess the perceived fatigue during and after a long-distance walk making the user learn his own fatigue perception. Last, PACES-It-8 will provide a rapid and reliable way to assess through a smartphone application the enjoyment after walking and after strength and balance intervention. It will be useful to assess the effect of physical activity on the quality of life. As a pilot study, the limitations of our study are several even if they can be bridged by the future directions that the project intends to explore. Future directions aim to an innovative and robust methodology that will be proposed in a case series study. It will permit the evaluation both quantity and quality of physical activity offered with a lifelong learning approach and using a smartphone technology.

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