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General description
An important part of learning performance is influenced by individual characteristics. One of those are the environmental influences determined by lifestyle. We call these influences biological lifestyle factors (BLFs). Physical activity, sleep and nutrition are such BLFs and they contribute to brain health, cognitive performance and learning performance in traditional education in children and adolescents. Little research, however, has been conducted concerning these BLFs in adults participating in distance education, despite that this type of education is more and more in favor because of the freedom it offers that allows combining it with the demanding work life, family responsibilities (e.g., a partner and/or children) and the need for ongoing development in adult life. Knowledge on how lifestyle could contribute to learning performance in adults is highly desirable as it could increase the success of adults participating in distance education. Besides, advice on lifestyle changes are relatively cheap interventions of which benefits could be substantial (Ribeiro & Stickgold, 2014).

Maintaining a healthy lifestyle does not only result in a better physical and mental health state (Busch, Van Stel, Schrijvers, & de Leeuw, 2013), but also leads to better cognitive performance (Small et al., 2006). Research indicates that a healthy lifestyle is beneficial for cognition and learning, as suggested by research in the domain of physical activity (PA) (e.g., Hillman, Kamijo, & Scudder, 2011), sleep (e.g., Dewald, Meijer, Oort, Kerkhof, & Bögels, 2010; Philip et al., 2012) and nutrition (e.g., Burkhalter & Hillman, 2011; Deliens, Clarys, De Bourdeaudhuij, & Deforche, 2013).

These examples provide the theoretical framework for the execution of this PhD project as PA, sleep and nutrition are all three factors that influence the body in a biological way. They exert influence on the regulation of the body's physiological parameters and the subsequent processes. We will not go into detail on these underlying processes in this proposal because of briefness, but we refer to the following literature (cf., Gómez-Pinilla, 2008; van Praag, 2009; Winter et al., 2007; Wright et al., 2013). These, by lifestyle induced, physiological changes influence processes among which are synaptic pruning, synaptic plasticity and neuronal proliferation. These all contribute to brain plasticity, which is believed to be the basis for better cognitive and learning performance (e.g., Barenberg, Berse, & Dutke, 2011).

This led us to investigate the following main research questions in an educational setting different than traditional education for children, namely adult distance education: What are the characteristics of adult distance education with respect to dropout and success? What is the relation(s) between behavior on BLFs on the one hand and cognition and learning performance on the other? The objectives of the PhD project were: (1) to elaborate on the

relation of the variables within each BLF with learning performance, but also combining these relations into one model predicting learning performance; (2) to elaborate on the relation of the variables within each BLF with cognitive performance, but also combining these relations into one model predicting cognitive performance; (3) to investigate whether cognitive performance was a mediator in the relation between the BLFs and learning performance.

The research proposed to be presented here, stems from a PhD project that will be finished at the time of the conference. The results from the first five, already available, empirical research articles will be presented in a concise but clear manner. One more research article is expected to follow in the future and will most likely be available at the conference and included in the paper presentation.

Methods

The Adult Learning Open University Determinants (ALOUD) study conducted within this PhD project consisted of a longitudinal data collection in which all new students (N=4945) of the Open University of the Netherlands (OU) who were admitted between September 2012 and August 2013 were invited. The full design is described in our data paper (Neroni, Gijselaers, Kirschner, & de Groot, 2015). Via survey research, independent measures were collected within 9 weeks after invitation. These measures were the variables within the BLFs: physical activity, sedentary behaviour, chronotype, sleep duration, sleep quality, sleepiness, fatigue, caffeine, fish consumption, breakfast consumption and breakfast composition. The measured covariates were: age, sex, educational level, body mass index, study goal, study motive, study hours, working hours, computer abilities, nationality, native language, alcohol use, smoking, drug use and life satisfaction. The outcome measures were the cognitive variables: processing speed and two executive functions: updating and shifting. The cognitive measures were collected via digital online cognitive tests. The main outcome measure on learning performance was study progress, measured as completed courses over the first 14 months (i.e., the official time a registration for a course lasts at the OU). The educational model at the OU is modular, students can start whenever they want and with any possible study path they want.

At first measurement, 2040 students fully responded. With these data, all analyses were executed.

One article concerns a description of the full data sample with regard to covariates for successful, non-successful and non-starting students. Three articles concern the prediction of study progress for physical activity, sleep and nutrition, respectively. These articles employed a multiple regression technique with a negative binomial distribution (as the outcome measure was not normally distributed). The last article concerns the prediction of cognitive performance from all the BLFs. A structural equation methodology was used to execute path analysis, using a cross-validation technique.

Results

Summarized -in order of appearance per article- analyses revealed that:

1. There are many differences in the characteristics between successful, non-successful and non-starting students.
2. Physical and sedentary behavior were not predictive for study progress opposite to our expectations.
3. Chronotype did not predict study progress, in line with previous research (Horzum, Önder, & Beşoluk, 2014; Jovanovski & Bassili, 2007; Önder, Horzum, & Beşoluk, 2011), sleep duration and sleep quality was not predictive for study progress, opposite to our expectation.

4. The consumption of fish, caffeine and breakfast did not predict study progress, in line with our hypotheses.
5. Sedentary behavior was predictive for cognitive performance. Physical activity, chronotype, sleep duration, sleep quality, caffeine, fish consumption and breakfast consumption were not predictive for cognitive performance.

These results will be extensively discussed during the paper presentation. Two more articles will be published in the coming months, when the PhD project is finalized. These results will also be included in the paper presentation.

Intent of publication

All research mentioned here will be published. Four articles are submitted and under review or revision. The fifth article is being finished and submitted soon. In the following months a sixth article will be written. Also this articles will be published.

This specific submission is an overview of the entire PhD project and will be published as the final doctoral thesis.

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