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Executive Functioning as a Predictor of Physical Activity and Treatment-Success of a Lifestyle Intervention for Inpatients in Long-term Psychiatry.

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Abstract

It has well been established that mortality rates among people with severe mental illness (SMI) are very high compared to the general population. This is often a result from medical conditions such as coronary heart disease. The contribution of sedentary behavior to high mortality rates is receiving increasing attention and has become a target point of lifestyle-interventions in intramural mental healthcare. As emerging evidence shows that engaging in health-behaviors such as physical activity is dependent of self-control mechanisms in the form executive functions, the current study aimed to probe a causal relationship between executive abilities and physical activity in people with SMI. It also aimed to prove that executive functioning predicts the increase in physical activity after participating in a lifestyle intervention. A study was conducted among inpatients (*N*=54) of long-term mental health care institution ‘Zon en Schild’. Participants were assessed with neuropsychological tests for executive functions. Physical activity (PA) was measured with accelerometers on two separate occasions. After the first measurement, part of the participants were assigned a lifestyle program. The second measurement took place after the lifestyle intervention. The current study failed to demonstrate a predictive role of executive functioning on physical activity for people with SMI. The study was also unsuccessful in supporting the hypothesis that higher levels of executive functioning predict better intervention-outcomes for physical activity. However, Verbal IQ was an unanticipated significant predictor to physical activity. It should be acknowledged that the risk of a type II error is substantial for this study due to power limitations

Voorwoord

Met het voltooien van deze scriptie, rond ik eveneens een periode van ruim 5 jaar op de Universiteit Utrecht af. Een onwerkelijk moment, waar ik me bij vlagen erg op heb verheugd, maar wat me op sommige momenten ook de nodige angst heeft ingeboezemd. Ik heb het studeren erg leuk gevonden en zelfs de thesis, waar ik aanvankelijk tegenop zag, met veel enthousiasme voltooid.

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Renée Copier

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In 2014, over 87.000 people with various pathologies were hospitalized in mental health care institutions in the Netherlands (Centraal Bureau voor Statistiek [CBS], 2014) and the latest figures show that the number of patients is still growing today (Organisation for Economic Co-operation and Development [OECD], 2015). A large proportion of the hospitalizations in mental health care is attributable to patients with severe mental illness (SMI). SMI is an umbrella term used for psychiatric disorders like schizophrenia, bipolar disorder and severe depression; disorders that are generally chronic and incurable, and come with serious functional impairments such as poor self-care and difficulties in maintaining occupational- and basic social roles, (Davis & Brekke, 2014). Many patients with SMI need lifelong treatment, which frequently occurs in long-term hospitalizations in mental health-care (Rössler, Joachim Salize, van Os, & Riechler-Rössler, 2005).

Aside from the profound mental and functional disturbances that SMI is associated with, many psychiatric patients also experience problems regarding their physical health. These problems are often a result of medical conditions, such as obesity, coronary heart disease, COPD and diabetes (Cabassa, Ezell, & Lewis-Fernández, 2010). In fact, people suffering from severe mental illness are predicted to live 13 – 30 years shorter compared to the general population (de Hert et al., 2011), even in countries that are known for their wealth and good health care services (Tiihonen et al., 2009). This dramatic decline in life-expectancy is largely due to cardiovascular deaths (Brown, Inskip, & Barraclough, 2000). Cardiovascular disease (CVD) is a collective term for numerous problems concerning the heart and blood vessels and is 2 to 3 times more common in people with SMI than in the general population (Brown et al., 2000). The main causes and aggrevators of CVD are poor dietary habits, smoking, and a lack of physical activity – behaviors that are all very prevalent in people with SMI (Cabassa et al, 2010). On top of that, chronic use of antipsychotic medication is also known to affect the cardiovascular system, (Shulman, Miller, Misher & Tentler, 2014), causing an extra risk factor for CVD in this population. Strikingly, all of the above mentioned behaviors or conditions could be prevented or minimized: unhealthy food-intake is adjustable and physical inactivity and medication intake could be reduced (Robson & Gray, 2006) and would reduce risk of CVD. That means that the high mortality rates that are observed in people with a SMI are, at least to some extent, unnecessary and may be put to an end.

The significance of preventing much-occuring health-risk behaviors in people with SMI must have been an incentive for the Dutch Inspection of Health Care (IGZ) to define norms and guidelines for lifestyle-interventions in mental health care. Many health-care institutions already started implementing promotion of a healthy lifestyle into treatment progressively (Brunero & Lamont, 2010), but the IGZ now secures that institutions engage in efforts to improve a healthy lifestyle for inpatients by carrying out regular inspections (IGZ, 2012).

One of the main pillars of health promotion treatments is enhancing physical activity (PA). Lack of physical activity and high prevalence of sedentary behavior - activities that do not significantly increase energy expenditure above the resting level, such as lying down or watching tv - have been pointed to be a common problem in people with severe mental illness (Pate, O'Neill & Lobelo., 2008; Daumit et al., 2010; Ussher et al., 2010; Vancampfort et al., 2011) which has a large contribution to increased mortality rates. There is still a gap in knowledge about how much physical activity hospitalized people with SMI actually engage in, as most studies were conducted only among psychiatric outpatients.This knowledge gap was narrowed recently, when 184 inpatients in long-term mental healthcare-institution 'Zon en Schild' participated in a study of physical activity. With the use of accelerometers, devices that objectively measure physical activity (Pate et al., 2008; Faulkner, Cohn & Remington, 2006), this study identified that a large majority (84%) of the sample was predominantly sedentary (Deenik, 2014). Patients also spent significantly (up to 1.5 times) less time doing light (LPA) and moderate to vigorous (MVPA) physical activity like walking, doing housework or exercising, than a comparison-group of healthy employees (Deenik, 2014).

Now that physical activity in patients with SMI has been mapped out, one could wonder what the determinants to sedentary behavior are, and more importantly, how effective attempts are to adjust this behavior. The current study aims to investigate the contribution of cognitive functioning to different levels of physical activity of inpatients in long-term psychiatry. Also, it intends to investigate how personal successes- or failures on a lifestyle intervention for physical activity may be caused by individual differences in cognitive abilities.

Causes of sedentary behavior

Attempts have been made before to determine causes of sedentary behavior for people with SMI, with varying degrees of success. One study assessed barriers to physical activity in both an inpatient as an outpatient population of people with SMI. Many respondents reported to believe in benefits of exercise for physical and mental health and stated that they enjoy exercise. Moreover, around half of the respondents reported a high level of motivation to exercise more regularly (Ussher et al., 2007). This would give ground for optimism, but the study made a sad conclusion: The group of participants was predominantly sedentary. Apart from frequently reported reasons for not exercising, like bad weather or fatigue, a vast majority of respondents reported that they had little confidence in being able to exercise when stressed or sad (Ussher et al., 2007).

When grounded in the Theory of Planned Behavior (TPB; Azjen & Madden, 1986), these findings suggests that sedentary behavior in psychiatric patients could be a direct result of lack of self-efficacy. The TPB is a social-cognitive model of individual health behavior and posits that the immediate antecedent of any behavior (e.g. exercise) is the intention is to perform the given behavior. This intention, called 'behavioral intention', has three determinants that affect it: attitude towards the behavior and its outcomes; subjective norms – referring to perceived social pressure and approval of committing of omitting certain behaviors; and perceived behavioral control (Azjen & Madden, 1986), which is equivalent to self-efficacy (Fishbein & Cappella, 2006). When one of the key elements to this model, self-efficacy, is lacking, behavioral intention and behavior fails to come about.

However, findings from previous studies contradict this idea. In one study, self-efficacy and attitude towards physical activity were assessed and linked to physical activity data. As attitude and self-efficacy are crucial components to behavioral intention, one would expect a positive relation between these components and physical activity. Yet, such an association was not found, concluding that attitudes and self-efficacy do not seem to translate into actual physical activity in this sample (Deenik, 2014). This seems in concordance with other findings that behavioral intention does not necessarily lead to behavior. In fact, intentions account for only 28% of the variance in behavior (Sheeran, 2002), leaving a majority of variance in behavior unexplained and most of intentions unfulfilled. To further explain physical activity behavior, there is a need to regard physical inactivity as a problem of *self-regulation* rather than a problem of decision-making (Hall et al., 2008). The author of the TPB already suggested that people may not always have sufficient control over performing behavior to actually enact their intentions (Azjen, 1986). They may, for instance, not have access to the right resources, or opportunities to do so (Sheeran, 2002) or may have insufficient self-regulation capacities to translate their intention into action *(*Hofmann, Schmeichel, & Baddeley, 2012).

Self-regulation capacity refers to one's ability to set goals and perform purposive, goal-directed behavior (de Ridder & de Wit, 2010; Carver & Scheier, 2011). Setting a goal, and the road to achieving that goal, comes with a range of challenges. It includes decision making about what goal to chase, how to attain it and, after that, initiation and maintenance of the desired behavior. This requires skills that are of a rather cognitive nature, such as rational thinking, problem solving and planning (Rothman, Baldwin, Hertel & Fuglestad, 2011). The cognitive abilities that are specifically important to self-regulation, are called executive functions. Stated simply, executive functions refer to aspects of cognition that are called on in situations where brain and behavior cannot run on automatic (Blair & Ursache, 2011). This is exactly what happens when one tries to initiate or alter behavior, for instance when adjusting lifestyle habits. There are three core executive functions to be distinguished: working memory, set-switching ability and inhibitory control (Diamond, 2013). *Working memory* brings about active representations of goals and control of attention, and monitors goal-relevant information. This is crucial to keep health goals and intended behavior prominently available. Working memory also controls attention: it facilitates the ability to redirect attention away from tempting stimuli (a couch or a tv when one intends to work out) or suppress ruminative thoughts ("I am tired, I do not feel like working out"). *Inhibitory control* facilitates active inhibition of predominant impulses and habitual (automatic) behaviors, a difficulty often seen in health behavior. When that couch has gathered ones attention while one has planned to go for a walk, inhibitory control is the function that suppresses the habitual response to sit down. Inhibitory role is especially relevant when *changes* to lifestyle or behavior are made for this function prevents automatic behavior from taking place. Lastly, *task switching* generates the ability to switch between different tasks or means. It is a skill opposite to rigidity, making it possible for individuals to abandon means or beliefs that are not helpful in achieving their goals, and replacing them by alternative means and to adjust behavior accordingly (Blair & Ursache, 2011). It provides flexibility to adapt behavior to changing demands (Hofmann et al, 2012), for instance when one need to maintain a diet when on holidays or to reschedule a daily evening-walk when invited to a dinner party.

The connection between executive functions and self-regulation seems evident, and it has been affirmed that executive functioning is linked to physical activity and sedentary behavior too (Hall et al., 2008; Buckley, Cohen, Kramer, McAuley, & Mullen, 2014). Curiously, however, this link has not yet been explored for people with severe mental illness, despite structural evidence of impairments in cognitive functioning in this group.

Schizophrenic patients, for instance, show impairments in areas such as learning, memory, verbal abilities and executive functioning (Heinrich & Zakzanis, 1998; Holt, Wolf, Fünke, Weisbrod, & Kaiser, 2013). For mood-disorders such as bipolar disorder and recidivating depression, neurocognitive deficits in verbal fluency, executive functioning and short-term memory, are also recognized (Burdick, Ketter, Goldberg & Calabrese, 2015; Boeker, Schulze, Richter, Nikish, Schuepbach, & Grimm, 2012).

As health behaviors, like physical exercise, rely heavily on self-control, sedentary behavior in patients with SMI may be the outcome of observed deficiencies in cognitive functioning. Therefore, the role of executive functioning in physical activity for patients with SMI should be further investigated. Given the elevated rates of morbidity and mortality among adults with SMI, probing this relationship is of vital importance to a large but vulnerable group in society.

Current study

The current study focuses on the relationship between executive functioning and sedentary behavior in patients with SMI in two ways. Firstly, it explores how these cognitive functions are related to levels of physical activity and tries to uncover if better executive abilities lead to more physical activity. The second focal point is the role of executive functioning in the effectiveness of a lifestyle intervention in patients with SMI. It is expected that patients with better executive abilities benefit more from the lifestyle-intervention than their lower-functioning counterparts, resulting in higher improved levels of physical activity after the intervention.

This study is a follow-up of Deenik's 2014 study on physical activity levels in patients with SMI and contains a pre- and post-intervention measurement of physical activity Inpatients of a long-term mental care institution who have participated in two physical activity measurements (T1 and T2, pre-and post-intervention), will be assessed with various neuropsychological tests that are linked to executive functions. Part of the participants have undergone an intervention focused on lifestyle. This intervention was set up after the first measurement of physical activity, and is expected to have increased physical activity levels by T2. The rest of the participants have not undergone an intervention and account for the control group. Hypotheses for this study are the following:

I. Executive abilities positively predict the amount of physical activity that people with severe mental illness engage in.

II. Executive functioning predicts treatment-success of a lifestyle intervention. Better executive functioning is linked to a larger increase in physical activity after a lifestyle intervention..

Methods

Design

This study had both an cross-sectional as a quasi-experimental design, being part of a cohort-study of inpatients in long-term mental health care. In the first place, the study aimed to assess how the independent variable, executive functioning, could predict levels of the dependent variable, physical activity by the baseline measurement T1. Secondly, the study contained a between group design, involving within subjects measurements of physical activity. In this design, the treatment condition (intervention or control group) was the independent variable. Executive functioning was a predictor- and possible moderator variable and difference scores of physical activity the dependent variable. In both designs, demographic variables, diagnosis and verbal IQ were added as covariates in the analysis. Schizophrenia and schizophreniform disorders are associated with higher levels of physical activity (Deenik, 2014) and will therefore be controlled for. Age is linked to poorer performance on cognitive tests (Avolio & Waldman, 1990) as well as more sedentary behavior (Deenik, 2014). Verbal IQ is added as a control variable too in order to address the influence of executive functioning solely and without the interference of other cognitive functions (Menon, Jahn, Mauer & O'Bryant, 2013; Wongupparaj, Kumari & Morris, 2014).

Participants

Participants were recruited among GGz Centraal's location 'Zon en Schild'. This location distinguishes five separate departments of long-term psychiatry. Within these departments, patients with similar types and degrees of severe mental illness live together in units of 10-15 people each. Participation in the study was voluntary. Inclusion criteria were the following:

- Sufficient physical activity-data was obtained in both measurements of PA (T1 and T2);
- Verbal IQ had previously been assessed and scores of Verbal IQ were available.

Of all 251 patients, 75 met the inclusion criteria. Some were considered unfit for participation due to their current mental state (n=6). Others had moved out of the institution (n=4) or were not included on other grounds. Six patients refused participation in the study. Participants were removed from the analysis if data for more than one executive functioning test was missing. This was the case for two participants. Drop-out numbers are presented in Figure 1.

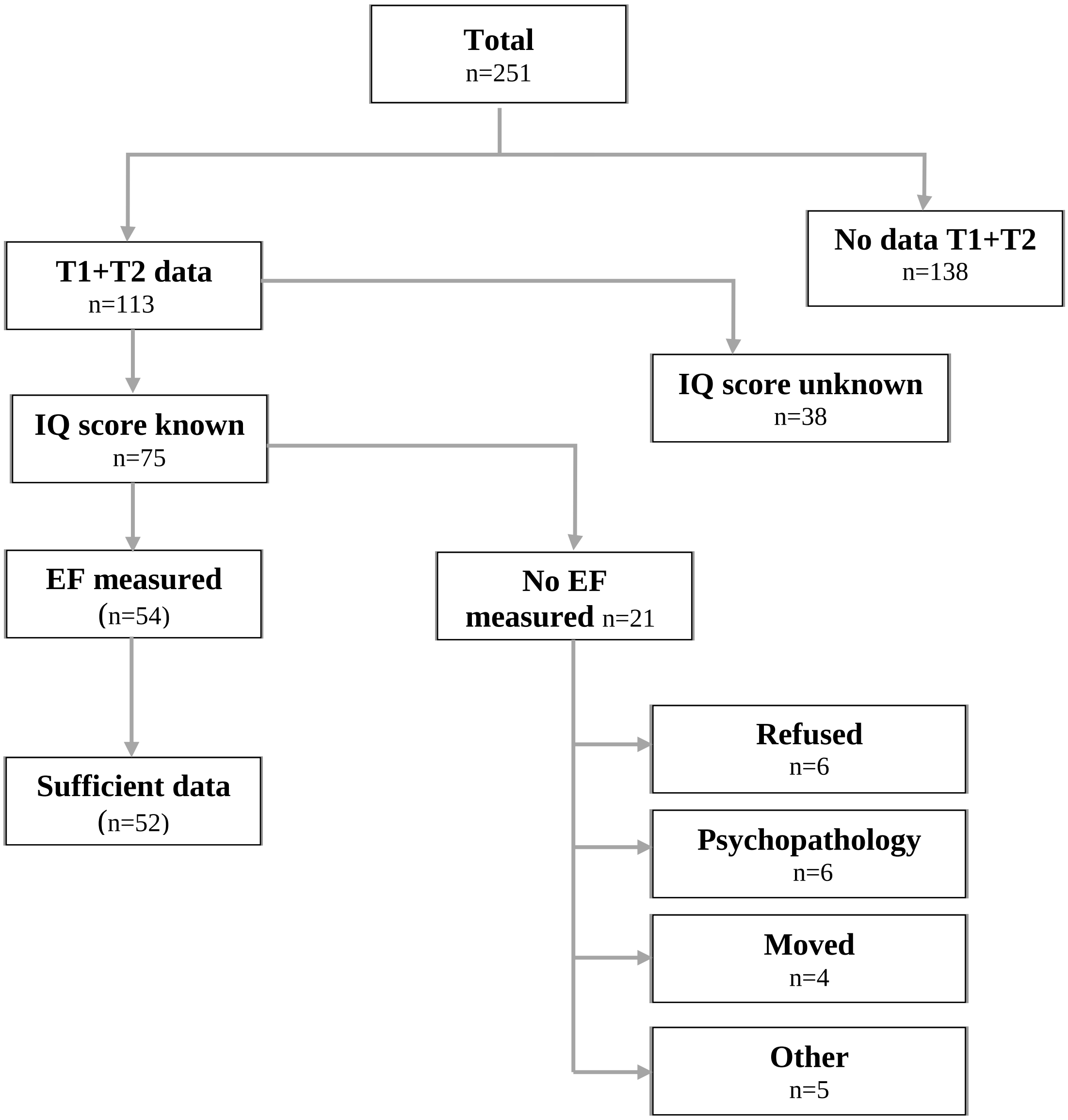

Figure 1: Flowchart with number of dropouts. Notes: EF = executive functioning.

Intervention

A majority of 60% the participants lived in special lifestyle groups. These lifestyle groups were established in 2014 as a health intervention-program which focusses on healthy diet and exercise. This intervention contained the following:

- A personalized lifestyle-plan;
- Psychoeducation on nutrition and exercise from a dietician, once every two weeks;
- On weekdays, at least one hour of supervised exercise (e.g. sportshall, fitness, yoga) was included in the daily program;
- Grocery-shopping once a week, by foot;
- Walking to the activities and therapies on the Zon en Schild terrain. The location's shuttle

bus was no longer available, except for patients with physical disabilities.

Materials

Physical Activity (PA)

Physical activity data was obtained from the Zon en Schild lifestyle cohort-study database. In a previous study, physical activity of inpatients was measured with accelerometers. Participation was voluntary and allowed when it entailed no substantial risk for mental health decompensation. The accelerometers used for the study were of Actigraph, type GT3X+ (ActiGraph, Pensacola, Florida, VS). The accelerometers were either clipped onto the participants belt or secured to clothing at waist level with safety pins. Patients were included when they provided at least 6 hours of physical activity data during 3 to 5 days. Used outcome measures were: total counts per hour (TAC/h) and the percentage (%) of time spent in respectively sedentary behavior (SB), light physical activity (LPA) and moderate to vigorous physical activity (MVPA). Exact procedures on collecting physical activity data for this study can obtained from Deenik, 2014.

Executive Functioning

Six neuropsychological tests were used representing the key facets to executive functioning. They will be elaborated upon below. Raw data were pre-entered in RSP 3.0 (Roermond's Score Programma; BAR Software, 2007), a psychological software tool that computes standardized individual test scores such as percentile scores and Wechsler subtest-scores. Wechsler scores, ranging from 1-19, were used as outcomes for all tests. A factor analysis was performed on executive test-data. The tests loaded on one single factor. The scores for executive functions were reduced to a one factor total-score for each participant, which was used in the statistical analysis.

Corsi Block.

Corsi-Block or 'Spatial Span Test' is a task for non-verbal, visuo-spatial working memory. Even though the Corsi Block-test is a frequently used neuropsychological assessment-tool, little normative data exists and no clear rating of validity is available for adults with psychiatric disorders. Given the frequent use of the test in patients with schizophrenia

(Salamé, Danion, Peretti, & Cuervo, 1998) and the fact that Corsi Block has been linked to working memory tests in the Wechsler Adult Intelligence Scale (WAIS-IV)(Kessels, van den Berg, Ruis, & Brands, 2009), this test is considered fit for use despite lack of adequate norms. Reliability is considered sufficient based on recent standardization of administration procedures (Berch, Krikorian, & Huha, 1998). The Corsi Block test contains a wooden board (255 x 205mm) with nine blocks (30 x 30mm) that are placed at fixed locations. The experimenter tapped a number of blocks at a rate of approximately 1 cube per second. The block sequences gradually increased in length. In the forward condition, the participant had to tap this block sequence in the same order. (Kessels, van Zandvoort, Postma, Kappelle, & de Haan, 2000). In the backward condition, the block-span had to be tapped in reverse order (Kessels et al., 2008). The test was terminated if the participant failed to reproduce two sequences of equal length. There were two outcomes to this test: the Block Span, which equals the length of the last correctly repeated sequence, and the number of correctly repeated sequences. The Total Score was the product of these two outcomes and was computed into standardized scores ranging from 1-19 based on norms provided by Kessels and collegues (2008; 2000).

Stroop

The color-word Stroop-test is a widely used cognitive test, which identifies attention and inhibition-abilities. Reliability is rated high for the Stroop-test, construct validity is adequate (COTAN, 2002). The test consists of three parts. Part one is a reading task; names of four colors (red, green, yellow, blue) appear in black ink. Part two contains squares in the colors red, green, yellow and blue. Participants need to name the colors. The last part, the 'interference-test', has names of colors appear in different colored ink than the color named. Participants are required to say the color of the letters independently of the written word as fast as they can (Stroop, 1935). It takes about 5 minutes to finish all three conditions of the Stroop-test. Standardized scores ranging from 1-19 were computed based on the time it took to complete the interference condition (in seconds) and the number of errors.

Trail Making Test

The Trail Making Test (TMT; Delis, Kaplan & Kramer, 2001) is a classic test and may be considered a set-switching as well as an attention-task (Strauss, Sherman, & Spreen, 2006). It consists of parts 1 through 5. Every part consisted of a paper containing circles with letters and digits in it. In part 1, the participant is asked to line through the circles with a digit '3' in it. In part 2 and 3, participants had to sequence the circles in respectively numerical- and alphabetical order. In part 4, circles needed to be sequenced in the right order, *switching* digits with letters (e.g. 1-A-2-B-3-C). Finally, part 5 is a motor-speed task: participants had to follow the lines that connect circles. Participants are instructed to complete all five parts as fast and as accurate as possible. Every part of the test starts with a short rehearsal. When the instructions were understood clearly, participants started with the actual test. Standardized performance scores on the TMT range from 1-19 and are computed based on the time it takes to complete a condition and the number of mistakes (Delis et al., 2001). For this test, reliability and validity are adequate (Strauss et al, 2006).

WAIS-III Digit span

The digit-span test is a subtest of the Wechsler Adult Intelligence Scale (WAIS) and assesses verbal working memory. It is validated in both clinical as non-clinical samples. It consisted of two conditions. In the forward condition the experimenter read digit spans out loud with a speed of approximately 1 second per digit. The participant was asked to repeat this sequence directly after the experimenter finished. If the sequence was repeated correctly, one point was granted. The digit spans increased in length, starting from three digits. If two digit spans of the same length were repeated incorrectly, the test was discontinued. The procedure for the backward condition was the same, but participants were asked to repeat the sequences in backward order. The first digit span had a length of two digits. The total digit span score was computed based on the total score (number of correctly repeated sequences) and the length (longest digit span correctly repeated) of the two conditions and standardized into a totalscore between 1-19.

Tower of London (TOL)

Tower of London (Delis et al., 2011) is a planning-test, used for diagnosis of executive impairment. This test consists of five disks, ascending in size, and three rods. The participant is required to reach an arrangement that is similar to the presented tower on an illustration. This full-size illustration was presented in upright position before the participant. When arranging the tower, participants were instructed to use as few steps as possible. Participants were not allowed to move more than one disk at a time. It was also not allowed to place a bigger disk over a smaller one. Difficulty of the given arrangement increased step by step. Outcome measures were: time until first step, number of steps until correct and time (in seconds) until correct (Delis et al., 2011). The psychometric quality of the Tower of London-test is moderate according to COTAN; reliability is insufficient and construct validity adequate (2007). Available normgroups contain healthy individuals and neurologic patients.

TOL has not been validated for psychiatric patients. However, various studies have used TOL in assessing planning abilities in patients with schizophrenia and linked TOL-scores to functional outcomes (Morris, Rushe, Woodruff, & Murray, 1999; Greenwood, Wykes, Sigmundsson, Landau, & Morris, 2011).

Behavioral Assessment of the Dysexecutive Syndrome (BADS)

BADS (Wilson, Elderman, Burgess, Emslie, & Evans, 1997) is battery designed to predict everyday problems arising from impairments in executive functioning. It contains of 6 tests: Rule Shift Cards, Action Program, Key Search, Temporal Judgement, Zoo-Map and Modified Six Elements. The Modified Six-Elements Test has been found to be an exceptionally sensitive test, integrating the skills that represent executive functioning in schizophrenia (Evans, Chua, McCanna & Wilson, 1997). It contains of three tasks (dictation, writing down the names of pictures and simple arithmetic), each consisting of two sections, A and B. Participants were given 10 minutes to complete at least some of every six of the tasks. They were not allowed to do section A and B from the same task one after the other. Once it was clear the participants understood the instructions, an alarm-clock was set and put in front of the participants. This allowed them to see the time remaining for the task. Scoring is based on the number of tasks attempted, the number of rule breaks made an the maximum of time spent on a separate task. Standardized profile scores range from 1 – 4 (Wilson et al., 1997).

The BADS has not yet been validated by COTAN, but various studies show that reliability adequate is rated high and ecological validity is superior to other executive tests (Chamberlain, 2003; Katz, Tadmor, Felzen, & Hartman-Meiar, 2007; Norris & Tate, 2010).

Verbal IQ

Verbal IQ was obtained from the Zon en Schild cohort database. IQ tests were assessed in 2013 with the WAIS-III, for which reliability is rated high and construct validity is adequate (COTAN, 2011). Verbal IQ was used as a substitute for TotalIQ. Completion of the full WAIS-intelligence test not achievable because of the research population.

Procedure

Patients were approached unit-wise. The nursery staff introduced the experimenters to the patients during scheduled group moments and motivate patients take part in the study. Depending on their level of autonomous functioning, participants were either invited to make an appointment for testing or were approached on their units at unplanned moments to ask if they were free and willing to participate. Participants were briefed about the study through a letter and received explanation orally if desired. The briefing explained the purpose of the study and contained statements concerning privacy and voluntarity of participation. After the briefing, an informed consent was handed and signed.

Testing took place in Zon en Schild offices closest to the unit the participant resided from. Some situations demanded that testing took place in the common room or a bedroom. As the complete set of neuropsychological tests takes approximately one hour to finish and most participants had a very limited attention span, testing took place during two or sometimes three to four separate occasions. This complicated the aim to take the tests in a fixed order. The average duration of each appointment was 20-30 minutes.

Statistical analyses

All statistics were computed using IBM SPSS version 23.0. Histograms and skewness of all predictor variables were computed to check the assumption of normality. As no variable exceeded skewness of >1.0, no data transformation was applied. Boxplots were used to assess outliers and extreme values. Descriptive statistics were computed for demographic variables and standardization- and randomization checks were carried out with independent t-tests (for scale variables) and chi-square tests (for categorical variables). Both hypotheses were tested in a hierarchical multiple regression analysis with the enter method. To achieve the best possible statistical power, first predictor variables were assessed with a linear regression-association model and excluded if they contributed to less than 10% of the explained variance in the dependent variable . Age, diagnosis and verbal IQ were added as control variables in both regression models. Gender was an additional control variable for the first hypothesis. A *P*-value of <.05 was considered significant.

Results

Sample

Executive functioning was measured in a total of 54 patients (34 male, 20 female). 38 participants were in the intervention-group. The control group consisted of 16 participants. Ages ranged from 36 to 73 years with a mean of 54.78 (*SD* = 9.27). In the sample, 47 patients were diagnosed with schizophrenia or a psychotic disorder. Other diagnoses occurring in the sample were mood disorders (n=3), personality disorders (n=2) or pervasive development disorder (n=2). To guarantee representativeness of the study sample, standardization checks were performed to control for differences (gender, age, diagnosis, IQ and physical activity) between participants and drop-outs. No significant differences were observed.

A randomization check was carried out and showed no significant differences on independent- or control variables (gender, age, diagnosis, IQ and executive functioning) between the intervention group and the control group.

Descriptive statistics

Means and standard deviations were computed for all tests used. T-tests were carried out to check for sex differences in performance on cognitive tests. An independent samples t-test showed that there was a significant difference for Corsi Block scores between sexes, $t(52)=2.04$, $p < .05$, with a higher average performance on Corsi Block for male participants (M=7.38, SD=2.28) than for female participants (M=5.88, SD=2.30). A significant difference between men and women in verbal IQ scores was also observed, $t(52)=2.20$, $p <.05$. Men (M=74, SD=18.38) scored significantly higher on Verbal IQ than women (M=63.70, SD = 12.93). Other tests showed no significant differences in performance on cognitive tests between sexes. Descriptive statistics for cognitive tests are presented in Table 1a.

Descriptive statistics were also computed for physical activity with independent samples t-tests. Means and standard deviations are presented in Table 1b. When checking for sex differences for physical activity, independent samples t-tests also showed differences between sexes for physical activity. Male participants (M=8.38, SD = 4.41) spent significantly more time in moderate to vigorous physical activity than female participants (M=6.07, SD=3.20), $t(53) = 2.05$, $p <.05$. No significant differences were found for other aspects of physical activity (Table 1b).

Table 1a: *Descriptive statistics of neuropsychological tests for males and females in the whole sample*

	Male (n=33)		Female (n=19)	
Test[a]	M	SD	M	SD
Stroop	11.12	3.03	11.21	2.51
Trail Making Test	7.35	4.44	7.16	4.42
Corsi Block	7.38*	2.28	5.88*	2.30
Tower of London	6.41	3.69	4.50	4.05
Digit Span	8.26	3.17	7.90	3.23
6 Elements	9.97	5.69	8.68	5.68
Verbal IQ[b]	74*	18.38	63.70*	12.93

[a]: all possible test-score outcomes range from 1-19, unless otherwise noted.
[b]: outcomes range from 42 to108

*: mean difference between male and female is significant for this test at level α= .05(two-tailed)

Table 1b: *Descriptive statistics for physical activity for males and females in the whole sample*

	Male (n=34)		Female (n=20)		
	M	SD	M	SD	*p*
TAC/h	34220.78	15627	26308.84	12339.45	.058
% sedentary	78.95	9.15	83.45	5.69	.053
% light	12.67	8.25	10.48	4.39	.28
% MVPA	8.38	4.41	6.07	3.20	.046*

Note: TAC/h = total physical activity counts per hour.

*: significant at level α= .05(two-tailed)

Statistical analysis

Partial correlations were computed between executive functions and physical activity levels and are presented in Table 2. Control variables were age, gender, diagnosis and verbal IQ. Opposite to the expectations, the total score of executive functions correlated negatively with physical activity, albeit not significant. A number of individual executive function-tests (Trial Making Test, Corsi Block) were negatively correlated to the total amount of physical activity as well. Moreover, higher scores on the Corsi Block test significantly positively correlated with more sedentary behavior. This implies that higher working memory abilities correspond with time spent in sedentary behavior.

Table 2

*Partial correlations for executive functioning scores and physical activity, controlled for age, gender, diagnosis and verbal IQ (*N=51).

Variable	TAC/h	SB	LPA	MVPA	ΔT2-T1
EF total score	-0.19	-0.15	-0.12	-0.11	-0.01
Stroop	-0,03	0.03	-0.01	-0.06	0.23
Trail Making Test	-0.19	0.19	-0.17	-0.1	0.01
Corsi Block	-0.40**	0.38**	-0.31*	-0.28	-0.06
Tower of London	-0.30*	0.17	-0.07	-0.27	-0.24
Digit Span	0.10	-0.11	0.08	0.10	0.13
6 Elements	0.13	-0.15	0.01	0.16	-0.04

Notes: TAC/h= Total Activity Counts per hour; SB = % in sedentary behavior; Light = % in LPA = % in Light activity; MVPA = % in moderate to vigorous activity; ΔT2-T1= difference score T2-T1. EF total = Executive functions total factor score,

* significant at level α= .05(two-tailed), ** significant at level α=.01(two-tailed)

Hypotheses testing

A three stage hierarchical multiple regression model was conducted to assess whether executive functions predicted the average amount of total activity at T1 in people with severe mental illness. This hypothesis was tested for the entire SMI-sample. At step one, variables gender, age and diagnosis were added to control for. Verbal IQ, also a control variable, was added at step two. Executive Functioning (EF) was added with step three, using the enter method. The analysis revealed that, inconsistent with the hypothesis, executive functioning was no significant predictor of physical activity after controlling for demographic variables and verbal IQ, β=-0.21, *t(46)*= -1.24, *p* = .22. The addition of executive functioning to the model did not increase the explained variance significantly, $F(1,46) = 1.54$, $R^2 = .02$. Verbal IQ, however, did significantly predict total activity counts per hour, β=0.28, *t(47)*= 2.14, *p* <.05, indicating that higher verbal intelligence is predictive of more physical activity. The total model was significant ($F(46,5) = 3.39$, *p* = <.05) and accounted for a moderate explained variance of .27 in the dependent variable ($R^2 adj = .19$). Outcomes of the regression analysis are displayed in Table 3.

It was expected that executive functions would moderate the relationship between the intervention and increased physical activity levels. The intervention was expected to be more effective to those higher in executive functioning. A hierarchical regression with the enter method was performed in four steps, with difference scores for TAC/h between T2 and T1 as a dependent variable. Step one included control variables gender, diagnosis and age. In step two, verbal IQ was added. Step three included executive functioning and condition. In step four, the interaction effect between intervention and executive functioning was added. The analysis revealed no significant main effect for condition, β=-0.54, *t*(43)=-0.32, *p* = .75, nor for executive functioning, β=0.08, *t*(43) = 0.38, *p* = .71, indicating that both the intervention and executive functioning could not significantly predict any expected increase in physical activity after the lifestyle intervention. Also, no significant interaction effect was found between condition and executive functioning β=-0.14, *t(44)*= -0.75, *p* = .46. The increase in physical activity levels for participants was not moderated by performance on executive functioning. A summary of the regression analysis is presented in Table 4.

Table 3

Summary of hierarchical regression analysis: executive functions as a predictor of physical activity (N=52).

	Model 1		Model 2		Model 3	
Variable	*B*	SE *B*	*B*	SE *B*	*B*	SE *B*
Gender[a]	-5939.49	3232.26	-3557.63	3312.35	-4046.53	3316.95
Age	-392.31	168.31	-391.29	162.40	-432.93	164.93
Diagnosis[b]	-3500.08	4568.67	-3382.82	4408.53	-4134.50	4425.20
VIQ			207.83	97.34	296.26	120.22
EF					-3184.88	2567.84
F	3.32		3.81		3.39	
R^2	0.17		0.25		0.27	
F change in R^2	3.32		4.56		1.54	
sig. F change	.027*		.038*		.22	

Notes: Dependent = physical activity (counts per hour); VIQ = Verbal IQ; EF = executive functioning (total factor score). Age, VIQ and Executive were centered at their means.

[a] male = 0, female = 1

[b] schizophrenia = 0, other diagnoses = 1

* significant at level α= .05 (two tailed)

Table 4

Summary of hierarchical regression analysis: interaction effect

	Model 1		Model 2		Model 3		Model 4	
Variable	*B*	SE *B*	*B*	SE *B*	*B*	SE *B*	*B*	SE *B*
Age	-0.02	0.02	-0.02	0.02	-0.02	0.02	0.02	0.02
Diagnosis[a]	0.57	0.40	0.56	0.40	0.62	0.43	0.66	0.43
VIQ			-0.01	0.01	-0.01	0.01	-0.01	0.01
EF					0.03	0.24	0.12	0.27
condition[b]					-0.20	0.35	-0.16	0.36
EF x condition							-0.33	0.40
F	1.64		1.33		0.84		0.81	
R^2	0.06		0.08		0.09		0.10	
F change in R^2	1.63		0.74		0.17		0.70	
sig. *F* change	.21		.40		.85		.41	

Notes: Dependent = Difference physical activity T2-T1 (counts per hour);); VIQ = Verbal IQ; EF = executive functioning (total factor score). Age, VIQ and Executive were centered at their means.

[a] schizophrenia = 0, other diagnoses = 1

[b] intervention = 0, control = 1

* significant at level α= .05 (two tailed)

Discussion

As it is known that sedentary behavior is a common problem in people with severe mental illness (Daumit et al, 2009) that is linked to high mortality rates (Brown et al., 2000), interest has been growing to the determinants to this behavior. Based on findings from previous research, it was hypothesized that executive functioning could be linked to the amount of physical activity that people with SMI engage in. Better abilities in executive functioning would predict higher overall levels of physical activity and less sedentary behavior. The second hypothesis stated that executive abilities would predict the increase of physical activity after undergoing an intervention on lifestyle. In fact, it was proposed that executive functioning would moderate the effect of the lifestyle intervention. Executive functioning would interact with the intervention in a way that participants in the intervention group with better executive abilities would increase more in physical activity levels compared to those with lower executive abilities.

The present study failed to find support for both these hypotheses. Opposite to the expectation, executive functioning was not predictive of physical activity after controlling for demographic variables, diagnosis and verbal IQ. Also, the study was unsuccessful in finding a significant interaction-effect between executive functioning and effectiveness of the lifestyle intervention. The lifestyle intervention seemed equally effective for those with higher and lower executive abilities. Various causes should be taken into account to interpret these unforeseen results.

Methodological limitations

Some limitations of the present study should be acknowledged. Firstly, statistical power was restricted due to a small amount of participants. According to a formula by Green, the minimum sample size to accomplish sufficient statistical power in a multiple regression analysis with six predictor variables would be 98: a constant of 50 participants and 8 participants added for each variable (Green, 1991). The estimated power of the current study is .33, while many researchers use .80 as a standard for adequate power (Wilson Vanvoorhis & Morgan, 2007) . This implies that the chance of a type II error is substantial: there is a possibility that the hypothesis is true, but was not detected in the study. Illustrative for a type II error in the current study, is the fact that it failed to include a significant treatment effect of the lifestyle intervention on physical activity that was found concurrently in the same study sample (Deenik, Tenback, Hendriksen, Tak & van Harten, 2016).

Naturally, the experimenters aimed for a bigger sample, but this striving was unworkable for two reasons: The complexity of the participants in the first place, and time constraints in the second place. Because of the challenging group that people with SMI in long-term psychiatry are, it took lots of time, effort and flexibility to motivate people into participation. Many patients were not used to-, neither capable of, concentrating on a task for more than 15 minutes. Some were too delusional or cognitively damaged to adequately follow directions. As only 74 participants had met the inclusion criteria, the initial aim of 96 participants was impossible to attain. A drop-out rate of over 25% brought the sample size further down.

Secondly, some remarks should be made about how the test scores came about. An important limitation was the fact that many cognitive tests were used that were not validated for psychiatric patients. The tests lacked adequate norms for the population, and the Corsi Block test had no scoring manual available at all. Also, one of the test leaders was not officially qualified to take psycho-diagnostic tests and some errors have been made in test examination- and scoring at especially the Tower of London task. These factors together may have biased the test-scores that were used for this study, and thus lessened the reliability and validity of the test results.

Theoretical remarks

Apart from methodological errors and power issues, questions should be posed if the hypotheses stated were substantively consistent with- and fit to the Zon en Schild lifestyle intervention. The initial approach of the intervention was to encourage a healthy lifestyle and regular exercise by giving psycho-education and facilitating sport activities on a facultative basis. The intervention had a strong educational set-up and promoted implementation of exercise and PA in daily life. However, very early on in the intervention, it became clear that this approach yielded no results (J. Deenik, 17-03-2016) and a different course was demanded. The intervention ended up rather structured, consisting of day to day programs with scheduled exercise activities. Participation was obligatory to all patients in the intervention group, and nursing staff monitored patients to follow their programs. In other words, the intervention turned into one of a predominantly behavioral nature. This appeared to be a good decision; the lifestyle-intervention has been confirmed effective in the study sample (Deenik et al., 2016) which compels with the idea that behavioral interventions are more adequate for changing physical activity in adults with severe mental illness than cognitive interventions (ter Meulen & de Haan, 2015; Conn, Hafdahl, Brown & Brown, 2008). On the other hand did the intervention no longer sort with the theoretical framework that led to our hypothesis. After all, it is substantiated that executive functions moderate treatment effects of an intervention through self-control (Buckley et al., 2008), implementation intentions (Hall, Zehr, Paulitzki & Rhodes, 2014) and behavioral intention (Hall, Fong, Epp & Elias, 2008), but the behavioral setup of the intervention did not call upon self-control or intentions at all. This may have caused executive functioning to be eliminated as a predictor for physical activity-outcomes of the intervention.

Still, it could be argued that logically, physical activity levels would have increased for people with better executive functioning, even outside of the obligatory exercise moments. Considering that barriers to engage in physical activity often involve limited experience (Johnstone, Nicol, Donaghy & Lawrie, 2009) and 'not knowing what to do' (Ussher et al., 2007; Vancampfort et al., 2011), participants in the intervention-group are given a considerable advantage above those in the control group: their participation in the lifestyle-program takes away the hurdle of unfamiliarity with exercise and should lead to more physical activity. Then, better executive functioning would be expected to be the predictor to implementing physical activities more often in daily life. Why did this fail to happen?

A probable explanation to this question is that motivation is lacking to perform PA behavior (Vancampfort et al., 2013). Vancampfort and colleagues examined motivational deficits in people with SMI linked to physical activity, utilizing the Self-Determination Theory (SDT; Deci & Ryan, 2000). The SDT proposes that motivation divides various qualitatively different types that can underly physical activity behavior. These types of motivation occur on a continuum of increasing autonomous motivation. On the lowest end of the continuum is amotivation. Amotivation is the case when people lack motivation to engage in physical activity, which naturally leads to no physical activity-behavior. Next, extrinsic motivation is the type of motivation where someone performs behavior for external reasons, such as obtaining approval or avoiding self-criticism. Then, the highest end of the continuum is intrinsic motivation, which represents the most autonomous and self-determined type of motivation. When someone is intrinsically motivated to perform physical activity, someone engages in physical activity for its own sake and experiences enjoyment or challenge through it (Vancampfort et al., 2013). The study showed effects, like a significant association between autonomous motivation and physical activity, and a negative correlation between amotivation and physical activity. More fascinating, though, is how external motivation was associated to less physical activity. External rewards, appreciation, criticism or punishment do not seem to have a positive effect on physical activity, the study concluded, and even lead to less physical activity. Given the fact that the lifestyle-intervention is to a large extent obligatory, it puts pressure to its participants and might result in a predominantly externalized type of motivation. As this type of motivation is associated with less PA, it is well possible that individual differences in motivation have influenced the amount of physical activity that people engaged in outside of obligated exercise moments. It might have party or fully substituted the effect of executive functioning on PA enhancement. The current study has not taken motivation into account. One could advocate to include this element in a next study as a predictor variable to attain better insights on factors underlying intervention-success.

Other findings and recommendations

Even though the current study could not substantiate the hypotheses, it provided some findings that are worth taking into consideration. One surprising result that was provided through the study, was the role of Verbal IQ. Verbal IQ was brought into the regression analysis as a control variable, but emerged as a variable of primary importance: it significantly predicted physical activity in people with SMI. While no literature has yet been published to support or explain the relation between verbal IQ and physical activity, verbal IQ has been linked to a number of positive functional outcomes in patients with schizophrenia, among which social functioning, occupational functioning and independent living (Green, 1996; Heaton & Pendleton, 1981). Furthermore, it is a widespread conception that intelligence predicts positive health outcomes and is associated with longevity, even when controlled for socio-economic status and material resource (Gottfredson & Deary, 2004). This may be a consequence of the fact engaging in health self-care behaviors requires some cognitive competence. Reasoning and learning capabilities are required to comprehend why and how a certain behavior influences physical health and cognitive abilities are needed to adequately bring the behavior into practice (Gottfredson & Deary, 2004). This is proven to affect medication-intake and dietary habits, but could also be applicable to physical activity.

Another plausible factor connecting Verbal IQ to physical activity, is social functioning. Social functioning includes engaging in adequate social behavior and the capability to maintain social relations, and is significantly correlated to Verbal IQ for patients with SMI (Leeson, Barnes, Hutton, Ron & Joyce, 2008; Green, 1996; Heaton & Pendleton, 1981). It has been concluded that patients with better social functioning engage in more social and recreational activities (Leeson et al., 2008). This could result in a higher amount of physical activity for patients with good social functioning compared to those who function poorly in this area. Social functioning could be regarded as a moderating variable between Verbal IQ and physical activity. Moreover, Verbal IQ has been found to be strongly related to emotional intelligence (Hogan, Parker, Wiener, Watters, Wood, & Oke, 2010) which is in turn linked to social support (Hogan et al., 2010). Social support is mentioned in a number of studies of health-behavior, for example in the Self-Determination Theory. The STD incorporates social support as a stimulative factor to intrinsic motivation (Deci & Ryan, 2000) and this relation has even been substantiated for people with SMI (Davis & Brekke, 2014). On the contrary, lack of social support has been reported to be an important perceived barrier to physical activity (Ussher et al., 2009; Rönngren, Björk, Haage & Kristiansen 2014). It can be said that this study revealed a contribution of Verbal IQ to physical activity in patients with SMI that cannot be disregarded in future research.

Ultimately, the current study showed us how difficult it is to obtain data from the specific group of inpatients in psychiatry. Extra time and effort is much needed to conduct a study that draws conclusions with sufficient statistical power. A key recommendation would be to replicate or extend the current study with more participants and a more reliable dataset when it comes to executive functioning tests. Measuring motivation for exercise would be another addition of advantage. When sufficient participants would be included in the study, a predictive regression model could be set up to gather further insights about which specific executive functions or motivational types are related to the different aspects of physical activity in people with SMI. These insights could be of much value to fine-tune lifestyle interventions for people with severe mental illness and contribute to a resolution to end to the terrible amount of premature deaths that is now reality in long-term psychiatry.

References

Avolio, B.J. & Waldman, D.A. (1990). An Examination of Age and Cognitive Test Performance Across Job Complexity and Occupational Types. *Journal of Applied Psychology*, 75, 1, 43-50.

Azjen, I. & Madden, T.J. (1986). Prediction of Goal-Directed Behavior: Attitudes, Intention and Perceived Behavioral Control. *Journal of Experimental Psychology*, 22, 453-474.

Berch, D.B., Krikorian, R., & Huha, E.M. (1998). The Corsi-block tapping task: Methodological and theoretical considerations. *Brain and Cognition*, 38, 317-338.

Blair, C. & Ursache, A. (2011). A Bidirectional Model of Executive Functions and Self-Regulation. In K. Vohs & R. Baumeister (Eds.), *Handbook of self-regulation: Research, theory, and applications* (2nd ed.; pp. 300-315). New York, NY: Guilford Press.

Boeker, H., Schulze, J., Richter, A., Nikish, G., Schuepback, D. & Grimm, S. (2012). Sustained Cognitive Impairment after Clinical Recovery of Severe Depression. *The Journal of Nervous and Mental Disease*, 200, 13, 773-776

Brown, S., Inskipp, H. & Barraclough, B. (2000). Causes of excess mortality in schizophrenia. *The British Journal of Psychiatry*, 177, 3, 212-217.

Brunero, S. & Lamont, S. (2010). Health Behavior Beliefs and Physical Health Risk Factors for Cardiovascular Disease in an Outpatient Sample of Consumers with a Severe Mental Illness: A Cross-Sectional Study. *International Journal of Nursing Studies*, 47, 753-760.

Buckley, J., Cohen, J.D., Kramer, A.F., McAuley, E. & Mullen, S.P. (2014). Cognitive control in the self-regulation of physical activity and sedentary behavior. *Frontiers in Human Neuroscience*, 8, 1-11.

Burdick, K.E., Ketter, T.A., Goldberg, J.F. & Calabrese, J.R., (2015). Assessing cognitive function in Bipolar Disorder: challenges and recommendations for clinical trial design. *Journal of Clinical Psychiatry*, 76, 3, 342-350.

Cabassa, L.J., Ezell, J.M. & Lewis-Fernándes, R. (2010). Lifestyle Interventions for People with Severe Mental Illness; a Systematic Literature Review. *Psychiatric Services,* 61,8, 774-782.

Carver, C. S., & Scheier, M. F. (2011). Self-regulation of action and affect. In K. D. Vohs & R. F. Baumeister (Eds.), *Handbook of self-regulation: Research, theory, and applications* (2nd ed., pp. 3-21). New York, NY: Guilford.

Chamberlain (2003). The Behavioral Assessment of the Dysexecutive Syndrome reviewed. *Journal of Occupational Psychology, Employment and Disability*. 5, 2, 33-38.

Centraal Bureau voor Statistiek. (2014). *Curatieve GGZ; zorgtrajecten per diagnose, leeftijd, zorgkenmerken*. Retrieved 26-10-2015, from http://statline.cbs.nl/Statweb/publication/?DM=SLNL&PA=81621NED

Conn, V.S., Hafdahl, A.R., Brown, S.A. & Brown, L.M. (2008). Meta-Analysis of patient education interventions to increase physical activity among chronically ill adults. *Patient Education and Counseling*, 2008, 157-172.

Davis, L. & Brekke, J. (2014). Social support and functional outcome in patients with severe mental illness: The mediating role of proactive coping. *Psychiatry Research*, 215, 39-45.

Daumit, G.J., Goldberg, R.W., Anthony, C., Dickerson, F., Brown, C.H., Kreyenbuhl, J., Wohlheiter, K. & Dixon, L.B. (2005). Physical Activity Patterns in Adults with Severe Mental Illness. *The Journal of Nervous and Mental Disease.* 193, 10, 641-646.

Deenik, J. (2014). Fysieke activiteit en kwaliteit van leven in langdurig opgenomen patiënten met EPA. *Universiteit Twente*, 1-76.

Delis, D.C., Kaplan, E. & Kramer, J.H. (2001). *Delis-Kaplan Executive Function System (D-KEFS),* Pearson Assessment and Information B.V., Amsterdam.

Diamond, A. (2013). Executive Functions. *Annual Reviews. Psychology*, 64, 135-168.

Evans, J.J., Chua, S.E., McKenna, P.J. & Wilson, B.A. (1997). Assessment of the Dysexecutive Syndrome in Schizophrenia. *Psychological Medicine,* 27, 635-646.

Faulkner, G., Cohn, T., & Remington, G. (2006). Validation of a physical activity assessment tool for individuals with schizophrenia. *Schizophrenia research*, 82, 2, 225-231.

Fishbein, M. & Cappella, J.M. (2006). The Role of Theory in Developing Effective Health Communications. *Journal of Communication*, 56, 1-17.

GGZ Nederland (2014). *Sectorrapport ggz 2012: feiten en cijfers over een sector in beweging.* Retrieved 03-11-2015, from http://www.ggznederland.nl/uploads/assets/Sectorrapport%202012-web.pdf

Green, M.F. (1996). What are the Functional Consequences of Neurocognitive Deficits in Schizophrenia? *The American Journal of Psychiatry*, 153, 321-330.

Green, S.B. (1991). How many subjects does it take to do a regression analysis? *Multivariate Behavioral Research*, 26, 599-610.

Greenwood, K.E., Wykes, T., Sigmundsson, Y., Landau, S. & Morris, R.G. Tower of London versus Real-Life Analogue Planning in Schizophrenia with Disorganization and Psychomotor Poverty Symptoms. *Journal of the International Neuropsychological Society*, 17, 474-284.

Hall, P.A., Fong, G.T., Epp, L.J. & Elias, L.J. (2008). Executive function moderates the intention-behavior link for physical activity and dietary behavior. *Psychology and health*, 23, 3, 309-323.

Hall, P.A., Zehr, C., Paulitzki, J. & Rhodes, R. (2014). Implementation Intentions for Physical Activity Behavior in Older Adult Women: An Examination of Executive Function as a Moderator of Treatment Effects. *Annal of Behavioral Medicine*, 48, 130-136.

Heinrichs, K.W. & Zakzanis, K.K. (1998). Neurocognitive deficit in schizophrenia: a quantitative review of the evidence. *Neuropsychology,* 13, 3, 426-445.

Heaton, R.K. & Pendleton, M.G. (1981). Use of Neuropsychological Tests to Predict Adult Patients' Everyday Functioning. *Journal of Consulting and Clinical Psychology*, 49, 6, 807-821.

Hofmann, W., Schmeichel, B.J. & Baddeley, A.D. (2012). Executive functions and self-regulation. *Trends in Cognitive Sciences,* 16,3, 174-178.

Hogan, M.J., Parker, J.D.A., Wiener, J., Watters, C., Wood, L.M. & Oke, A. (2010). Academic success in adolescence: Relationships among verbal IQ, social support and emotional intelligence. *Australian Journal of Psychology,* 62, 30-41.

Holt, D., Wolf, J., Fünke, J., Weisbrod, M. & Kaiser, S. (2011). Planning Impairments in Schizophrenia: Specificity, task independence and functional relevance. *Schizophrenia Research.* 149, 174-179.

Inspectie voor de Gezondheidszorg (2012). Staat van de Gezondheidszorg. *Preventie in de curatieve en langdurige zorg: noodzaak voor kwetsbare groepen.* Retrieved 08- 11-2015, from http://www.igz.nl/Images/Staat%20van%20de%20Gezondheidszorg%20%28SGZ%29%202012[1]_tcm294-353626.pdf

Johnstone, R., Nicol, K., Donaghy, M., & Lawrie, S. (2009). Barriers to uptake of physical activity in community-based patients with schizophrenia. *Journal of Mental Health, 18*, 6, 523-532

Katz, N., Tadmor, I., Felzen, B., & Hartman, Maier, A. (2007). *Neuropsychological Rehabilitation*, 17, 2, 192-205.

Kessels, R.P.C., van den Berg, E., Ruis, C. & Brands, A.M.A. (2008). The Backward Span of the Corsi Block-Tapping Task and its Association with the Wais-III Digit Span.

Assessment, 15, 4, 426-434.

Kessels, R.P.C., van Zandvoort, M.J.E., Postma, A., Kappelle, L.J. & de Haan, E.H.F. (2000). The Corsi Block-Tapping Task: Standardization and Normative Data. *Applied Neuropsychology*, 7, 4, 252-258.

Kovács, F. (2007). *Tower of London test handleiding.* Voorhout: Pyramid Productions.

hoon, V.C., Barnes, T.R.E., Hutton, S.B., Ron, M.A. & Joyce, E.M. (2008). IQ as a Predictor of Functional Outcome in Schizophrenia: A Longitudinal Four-year Study of First-episode Psychosis. *Schizophrenia Research*, 107, 55-60.

Menon, C.V., Jahn, D.R., Mauer, C.B. & O'Bryant, S.E. (2013). Executive Functioning as a Mediator of the Relationship Between Premorbid Verbal Intelligence and Health Risk Behaviors in a Rural Dwelling Cohort: A Project FRONTIER Study. *Archives of Clinical Neuropsychology*, 28, 169-179.

Meulen, W.G. ter, & Haan, L. de, (2012). Interventies om mensen met schizofrenie aan het bewegen te krijgen. *Tijdschrift voor Psychiatrie,* 54, 8, 741-746.

Morris, R.G., Rushe, T., Woodruffe, P.W.R., & Murray, R.M. (1995). Problem solving in schizophrenia: a specific deficit in planning ability. *Schizophrenia Research*, 14, 235-246.

Norris, G. & Tate, R.L. (2010). The Behavioral Assessment of the Dysexecutive Problem: Ecological,Concurrent & Construct Validity. *Neuropsychological Rehabilitation.* 10, 1, 33-45.

Organization for Economic Co-operation and Development (OECD) (2015). Mental Health Analysis Profiles, *OECD Health Working Papers*, 6. Retrieved 09-01-2016 from http://dx.doi.org/10.1787/5jz158z60dzn-en

Pate, R.R., O'Neill, J.R. & Lobelo, F. (2008). The evolving definition of "sedentary". *Exercise and Sport Sciences Reviews*, 36, 4, 173-178.

Procare. (2012). ActiGraph™ GT3X+ Monitor: ProCare.

Ridder, D. de & Wit, J.B de . (2006). *Self-regulation in health behavior, concept, theories and central issues*. John Wiley and Sons, UK, 1-23.

Robson, D. & Grey, R. Serious Mental Illness and Health Problems: A Discussion Paper. *International Journal of Nursing Studies*. 44, 457-466.

Roermond Score Programma versie 3.0 [RSP] (2007). Bär Software bv, Baexum.

Rönngren, Y.M., Björk, A., Haage, D. & Kristiansen, L. (2014*).* Development of a Lifestyle Intervention Program for People with Severe Mental Illness: Physical Activtiy, Dietary Changes and Cognitive Adaptation Training. *Journal of Psychiatric and*

Mental Health Nursing, 21, 924-930.

Rössler, W., Joachim Salize, van Os, J. & Riecher-Rössler, A. (2005). Size of burden of schizophrenia and psychotic disorders. *European Neuropsychopharmacology,* 15, 4, 399-409.

Rothman, A.J., Baldwin, A.S.**,** Hertel, A.W., & Fuglestad, P. (2011). Self-regulation and behavior change: Disentangling behavioral initiation and behavioral maintenance. In K. Vohs & R. Baumeister (Eds.), *Handbook of self-regulation: Research, theory, and applications* (2nd ed.; pp. 106-122). New York, NY: Guilford Press.

Ryan, R.M. & Deci, E.L. (2000). Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development & Well-Being. *American Psychologist*, 55, 1, 68-78.

Salamé, P., Danion, J.M., Peretti, S. & Cuervo, C. (1998). The State of Functioning of Working Memory in Schizophrenia. *Schizophrenia Research,* 30, 1, 11-29.

Sheeran, P., Conner, M. & Norman, P. (2001). Can the Theory of Planned Behavior Explain Patterns of Health Behavior Change? *Health Psychology*, 20, 1, 12-19.

Sheeran, P. (2002). Intention-Behavior Relations: A Conceptual and Emperical Review. *European Review of Social Psychology,* 12, 1-35.

Shulman, M., Miller, A., Misher, J. & Tentler, A. (2014). Managing cardiovascular disease risk in patients treated with antipsychotics: a multidisciplinary approach. *Journal of multidisciplinary healthcare.* 7, 489-501.

Strauss, E., Schermann, E.M.S. & Spreen, O. (2006). *A Compendium of Neurpsychological Tests: Administration, Norms and Commentary.Third Edition.* Oxford University Press, New York.

Stroop, J.A. (1935). Studies of Interference in Serial Verbal Reaction. *Journal of Experimental Psychology,* 18, 643-662.

Tenback, D.E., van Kessel, F., Jessurun, J., Pijl, Y.J., Heerdink, E.R. & van Harten, P.N. (2013). Risicofactoren voor inactiviteit bij patiënten met ernstige psychiatrische aandoeningen in de langdurige zorg. *Tijdschrift voor Psychiatrie*, 55, 2, 83-91.

Tiihonen, J., Lönnqvist, J., Wahlbekc, K., Klaukka, T., Niskanen, L., Taskanen, A. & Haukka, J. (2009). 11 year follow-up study of mortality in patients with schizophrenia: A population-based cohort study (FIN11 study). *The Lancet,* 374, 9690, 620-627.

Vancampfort, D., Probst, M., Sweers, K., Maurissen, K., Knapen, J. & De Hert, M. (2011). Lack of physical activity during leisure time contributes to an impaired health related quality of life in patients with schizophrenia. *Schizophrenia Researchs,* 129, 2, 122-

127.

Vancampfort, D., De Hert, M. , Vansteenkiste, M., De Herdt, A., Scheewe, T.W., Soundy, A., Stubbs, B. & Probst, M. (2013). The importance of self-determined motivation towards physical activity in patients with schizophrenia. *Psychiatry Research,* 210, 812-818.

Vancampfort, D., Stubbs, B., Venigalla, S.K. & Probst, M. (2015). Adopting and Maintaining Physical Activity Behaviours in People with Severe Mental Illness: the Importance of Autonomous Motivation. *Preventive Medicine*, 81, 216-220.

Wilson, B.A., Alderman, N, Burgess, P.W., Emslie, H. & Evans, J.J. (1997). *Behavioural Assessment of the Dysexecutive Syndrome.* Pearson Assessment and Information B.V. Amsterdam.

Wilson VanVoorhis, C.R. & Morgan, B.L. (2007). Understanding Power and Rules of Thumb for Determining Sample Sizes. *Tutorials in Quantitative Methods for Psychology*, 3, 43-50.

Wongupparaj, P., Kumari, V. & Morris, R.G. (2015). Executive function processes mediate the impact of working memory impairment on intelligence in schizophrenia. *European Psychiatry*, 30, 1- 7.

Ussher, M., Stanbury, L., Cheeseman, V. & Faulkner, G. (2007). Physical Activity Preferences and Perceived Barriers among Persons with Severe Mental Illness in the United Kingdom. *Psychiatric Services,* 58, 3, 405-408.

Appendix I: briefing

Onderzoek naar fysieke activiteit en kwaliteit van leven

We vragen om uw medewerking voor dit onderzoek over fysieke activiteit en kwaliteit van leven bij mensen met een psychiatrische aandoening in de langdurige zorg.

Het is bekend dat mensen met een ernstige psychiatrische aandoening vaak weinig bewegen. Dit terwijl zij vaak wel meer zouden *willen* bewegen, en ook weten dat beweging gezond is. Zo verkleint het bijvoorbeeld het risico op hart- en vaatziekte en overgewicht. Ook zorgt beweging ervoor dat mensen zich gelukkiger voelen.
GGz Centraal wil graag onderzoeken hoeveel er wordt bewogen door mensen in de langdurige zorg, en kijken welke factoren de hoeveelheid beweging beïnvloeden.
GGz Centraal hoopt met dit onderzoek kennis te vergaren om mensen met een psychiatrische aandoening in de toekomst langer, gezonder en gelukkiger te laten leven.

Hoe zit het onderzoek eruit?

Fysieke activiteit is gemeten met behulp van een apparaatje, wat u 5 dagen bij u heeft gedragen. Deze meting is inmiddels afgerond. Nu zal er een aantal tests afgenomen worden, die onder andere over aandacht, geheugen en planning gaan. We kijken hoe deze dingen invloed hebben op beweging en uw kwaliteit van leven.

Wat wordt er van u verwacht?

Voor het testen maken wij graag een afspraak met u. We komen langs op de afdeling en spreken met u een rustige plek af om te testen. Dit gebeurt meestal op een kantoor op de afdeling. Het afnemen van tests duurt meestal niet langer dan een uur per keer. Soms zijn meerdere afspraken nodig.
Hoewel het woord ‘test’ misschien eng klinkt, zijn er geen ‘goede’ en ‘foute’ antwoorden of scores. Het is vooral belangrijk om in een ontspannen sfeer de tests te volbrengen.

Privacy

De uitkomsten worden anoniem verwerkt. Uw antwoorden worden niet gepubliceerd of verstrekt aan mensen buiten het onderzoeksteam.

Vrijwillige deelname

Deelname aan het onderzoek is vrijwillig. Dat betekent dat u op elk moment uw deelname mag onderbreken, met welke reden dan ook.

We kijken er naar uit om aan de slag te gaan met het onderzoek, en hopen op uw medewerking

Voor vragen over het onderzoek, kunt u contact opnemen met
Renée Copier, Carlijn Verhagen,
Onder supervisie van Jeroen Deenik en dr. Diederik Tenback.