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Motivational Reserve: Lifetime Motivational Abilities Contribute to Cognitive and Emotional Health in Old Age
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Abstract

The authors have recently developed the concept of motivational reserve, which implies a set of motivational abilities that provide the individual with resilience to neuropathological damage. This study investigates how lifetime motivational abilities are associated with current cognitive status, mild cognitive impairment, and psychological wellbeing in old age. A community sample of 147 non-demented participants aged between 60 and 94 years, stratified for age group, sex, and education, completed motivation and wellbeing questionnaires and cognitive tests. A new procedure was used to estimate their midlife motivational and cognitive abilities on the basis of the individual’s main occupation using the Occupational Information Network (O*NET) system. O*NET-estimated motivational abilities predicted cognitive status, psychological wellbeing, and odds of mild cognitive impairment, even when age, sex, education, and cognitive ability were controlled. Although O*NET-estimated cognitive abilities were not significant predictors, scores on a measure of crystallized intelligence were associated with current cognitive status and odds of mild cognitive impairment. Findings suggest that motivational reserve acts as a protective factor against the manifestation of cognitive impairment and emotional problems in later life.

Keywords: motivation, self-regulation, cognition, cognitive impairment, emotional health

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General Outline

As the numbers of adults over the age of 65 continue to rise throughout the world, preserving the cognitive and emotional health of older people has become a major societal challenge. With increasing age, the prevalence of cognitive impairment rises (Kuller, 2006), and the prevalence of other psychiatric disorders is considerable when subsyndromal conditions are included (Jorm, 2000a; Maercker et al., 2008). However, research on successful aging challenges the popular notion that aging invariably involves a decline in functioning and quality of life, and has identified factors that can increase individuals’ “health span” as they enter later life (Fries, 2002). The goal of current research on dementia and other psychiatric disorders is thus to identify both biological and psychological factors that may help people to maintain or enhance their cognitive and emotional health in older age (e.g., Fonda & Herzog, 2001; Jedrziewski, Lee, & Trojanowski, 2005).

A recent review identified several biological (genetic, cardiovascular and other physical factors) as well as psychological (cognitive, emotional, motivational, and social) risk factors for cognitive and emotional disturbances (Hendrie et al., 2006). The present study focuses on two categories of psychological factors: motivation and cognition. Alongside emotion, these two psychological functions are traditionally conceptualized as distinct, but interacting, mental systems in the “trilogy of mind” (Hilgard, 1980). Modern integrative perspectives on intellectual functioning and development still explore the interplay of cognition, motivation, and emotion (Dai & Sternberg, 2004). In the realm of educational and occupational attainment, achievement outcomes have often been regarded as a function of cognition and motivation, of “skill” and “will” (McCombs & Marzano, 1990), and modern
models of education and learning incorporate both aspects as strongly interrelated systems in comprehensive models (Boekaerts, 1996; Pintrich, 2004). In the realm of clinical psychology, many models of disorders and therapy incorporate motivational factors alongside cognitive, biological, and other factors (Bandura, 1997; Karoly, 1993; Maes & Karoly, 2005).

We have recently developed the motivational reserve (MR) model, which incorporates motivational and cognitive abilities as predictors of cognitive impairment and Alzheimer’s disease (AD). MR can be defined as a set of motivational abilities that provide the individual with resilience to neuropathological damage (Forstmeier & Maercker, 2007a). Specifically, MR is seen as a form of brain reserve that enables the brain to tolerate neuropathological age- and dementia-related changes without clinical manifestation (Fratiglioni & Wang, 2007; Stern, 2006; Valenzuela & Sachdev, 2006). Following Valenzuela and Sachdev (2006), neurological and behavioural brain reserves can be distinguished. In neurological brain reserve, structural neural characteristics (e.g., brain weight, number of neurons) are the basis of the brain’s resilience. In behavioural brain reserve, behavioural and mental training throughout life leads to a more efficient use of brain networks and compensation of disrupted networks. The most intensively investigated form of behavioural brain reserve is cognitive reserve (CR); premorbid cognitive abilities and activities are thought to be among the major contributors to brain reserve. Motivational reserve is also conceived to be a form of behavioural brain reserve, with premorbid motivational abilities and activities being hypothesized to contribute to brain reserve. In our model, MR and CR are complementary concepts.

Our model of MR is based on recent knowledge of motivational processes. Theoretically, the MR model focuses on the regulation of motivation (Gollwitzer & Bargh, 1996; Kehr, 2004; Kuhl, 2000; Kuhl & Fuhrmann, 1998), which involves different processes (e.g., decision regulation, activation regulation, motivation regulation, and self-efficacy; see
details below). Empirically, two motivational variables (goal orientation and action planning) that help the individual to effectively implement their intentions are investigated.

In this study, we further focus on the effects of lifetime motivational abilities on cognitive health in old age and their interactions with lifetime cognitive abilities and other variables. Moreover, we report the effects of midlife motivational abilities on emotional health. There is already much research on this association (e.g., Bandura, 1997; Kruglanski et al., 2000; Kuhl & Fuhrmann, 1998; Tangney, Baumeister, & Boone, 2004). The MR approach extends on the previous literature on motivation and health by focusing on the prediction of cognitive decline and dementia (Forstmeier & Maercker, 2007a).

As depicted in Figure 1, we assume that MR affects current cognitive status. Cognitive reserve is also assumed to influence cognitive health either directly or via interaction with MR. We expect that when CR is high, the association between MR and cognitive health is less pronounced than when CR is moderate or low. Similarly, the current stress level is assumed to affect cognitive health directly and via interaction with MR. A high stress level would dominate the current health status and reduce the impact of MR on cognitive function, while low to moderate stress levels would facilitate the association between MR and health. Educational level and crystallized intelligence are included in the model because they are common variables influencing MR, CR, and current cognition. Age is considered as affecting the current stress level and cognitive status.

The next paragraphs outline selected previous research showing the influence of motivational and cognitive abilities on cognitive and emotional health.

Motivational Abilities as Predictors

Several findings suggest that motivational abilities predict cognitive function. Prospective studies have shown that self-directed occupational conditions increase intellectual functioning (Schooler, Mulatu, & Oates, 2004) and that self-efficacy predicts
memory performance in older people (Valentijn et al., 2006). Correlational studies have found that self-efficacy is associated with academic performance (Luszczynska, Gutiérrez-Doña, & Schwarzer, 2005). Indicators of motivational self-regulation have been found to be inversely associated with AD in case-control studies. For example, being strongly involved in important daily-life decisions (Bauer, Stadtmüller, Qualmann, & Bauer, 1995), working in one’s desired job (Kropiunigg, Sebek, Leonhardsberger, Schemper, & Dal-Bianco, 1999), and having a challenging job with high control possibilities (Seidler et al., 2004) are related to decreased risk. Finally, internal control, a construct similar to self-efficacy, correlates with hippocampal volume and is thus discussed as protective factor against age-related cognitive decline and hippocampal atrophy (Pruessner et al., 2005).

There is much research on the association between motivational abilities and emotional wellbeing. Prospective studies have found motivational self-regulation to predict depression (Rholes, Michas, & Shroff, 1989) and self-efficacy to predict a variety of emotional health outcomes (Bandura, 1997). Correlational studies have gathered consistent support for the association of motivational abilities and emotional health, e.g., psychiatric and psychosomatic disorders (Forstmeier & Rüddel, 2007; Hautzinger, 1994; Kuhl & Fuhrmann, 1998), in particular anxiety and depression (Kruglanski et al., 2000; Luszczynska et al., 2005).

Disentangling Cognitive Predictors

The established fact that cognitive abilities throughout life seem to protect against cognitive decline and to delay onset of AD symptomatology is reflected in the construct of cognitive reserve (Stern, 2002; Whalley, Deary, Appleton, & Starr, 2004). However, some of the measures assumed to reflect CR may in fact be permeated by motivational aspects. Premorbid intellectual functioning, years of education, occupational attainment, and number of mental activities are considered to index CR (see recent reviews by Fratiglioni & Wang,
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2007; Stern, 2006; Valenzuela & Sachdev, 2006). For example, premorbid IQ predicts cognitive impairment (Corral, Rodriguez, Amenedo, Sanchez, & Diaz, 2006) and incidence of AD (Whalley et al., 2000). Educational attainment predicts incidence of AD (e.g., Karp et al., 2004). Mental activities throughout life are also associated with the risk of AD in prospective studies (Verghese et al., 2003; Wilson et al., 2002).

Coming closer to the core of our own approach, occupational attainment has also been used as an indicator of CR. Several different measures have been applied, including socioeconomic status (e.g., Qiu et al., 2003), manual vs. non-manual occupations (e.g., Anttila et al., 2002), and complexity of occupation (Andel et al., 2005). These studies support the environmental complexity hypothesis, which states that cognitively demanding and complex occupations promote stable cognitive function by facilitating intellectual flexibility on a daily basis (Schooler, Mulatu, & Oates, 1999). Other studies have used measures of complexity of work with data, people, and things, based on data provided by the Dictionary of Occupational Titles (DOT; US Department of Labor, 1991). Complexity of work with data and people has been found to be associated with better cognitive functioning in a sample of older, non-demented individuals (Andel, Kareholt, Parker, Thorslund, & Gatz, 2007), complexity of work with people to be associated with a reduced risk of AD (Andel et al., 2005), and complexity of work with data and people to predict faster cognitive decline in AD patients (Andel, Vigen, Mack, Clark, & Gatz, 2006). Almost all authors applying the DOT interpret their findings in terms of CR, even when only complexity of work with people proved to be associated with a reduced risk of AD (Andel et al., 2005). Unquestionably, these DOT variables reflect the individual’s social abilities more than his or her cognitive abilities. The problem with these global constructs of complexity of work is that they reflect several abilities, including cognitive, motivational, and social abilities.
Motivational Reserve in the Occupational Context and its Basis

Motivational abilities are required to a greater or lesser extent in all occupations. The occupational context can be regarded as one of the areas of life in which motivational abilities play a crucial role in reaching one’s goals, to a greater extent than other areas of life such as relationships, child rearing, leisure activities, spirituality, and the dwelling place. Against this background, this study uses a new measurement procedure based on the individual’s main occupation to estimate former motivational abilities. During the development of this procedure, two variables emerged to be related to aspects of MR, namely goal orientation and action planning. Together, they cover the four sub-processes of motivational regulation.

The MR model can be further elaborated as follows: action-phase models of motivation (e.g., Heckhausen & Heckhausen, 2008) distinguish a pre-intentional phase (choosing between alternative goals) from a post-intentional phase (implementing the chosen goal). The most important motivational abilities—also called self-regulatory or volitional skills (Kuhl & Fuhrmann, 1998)—in the post-intentional phase are regulation of motivation, emotion, and attention (Kuhl, 2000). The construct of MR focuses exclusively on regulation of motivation. We therefore prefer the term “motivational” to “self-regulatory” or “volitional” in the present context.

Theoretically, different sub-processes are described: decision regulation, activation regulation, motivation regulation, and self-efficacy (Forstmeier & Maercker, 2007a). The first three regulation processes are relevant in different sub-phases of the post-intentional phase. Decision regulation (the skill of quickly coming to a self-congruent decision) is needed in the crossover to the post-intentional phase; activation regulation (the skill of readying oneself to act) is needed to initiate an action; and motivation regulation (the skill of motivating oneself to persevere) is needed to persevere with or to resume the action. The fourth aspect, self-
efficacy (the belief in being able to bring the intended behaviour to a successful conclusion despite difficulties) is important during the whole post-intentional phase: it determines the amount of perseverance and self-regulatory effort invested (Bandura, 1997).

Why should MR be expected to protect against cognitive decline? As mentioned above, MR can be described as a form of behavioral brain reserve. We hypothesize that exercising motivational abilities throughout life increases the number of synaptic connections and causes the brain to develop new neurons, leading to the more efficient use of relevant brain networks and to the compensation of disrupted networks.

There is plenty of evidence that the human brain still exhibits plasticity in adult and older life (Kempermann, Gast, & Gage, 2002). The brain areas primarily involved in motivational activities are the amygdale (fear-motivated behavior), the nucleus accumbens (reward-motivated behavior), and the prefrontal cortex (regulating motivational salience and determining intensity of responding; e.g., Cardinal, Parkinson, Hall, & Everitt, 2002; Kalivas & Volkow, 2005). The end results of life-long training are neuronal networks that are more efficient, plastic, and adaptive, translating into better performance in aging persons. These neuroplastic advantages of people with high motivational abilities may equip them with greater tolerance of AD pathology in these areas.

Besides this primary mechanism, additional factors might mediate the effect of MR on further brain areas. These factors operate by influencing stress activation, vascular risk factors, cognitive training, and emotional health. In terms of stress activation, motivational abilities are known to be important in stress management, modulating the stress response (Beckmann & Kellmann, 2004; Rudolph & McAuley, 1995). High concentrations of stress hormones seem to be associated with impaired cognitive function and hippocampal atrophy in AD (Belenoff, Gross, Yager, & Schatzberg, 2001; Lupien et al., 1999). In terms of vascular risk factors, individuals with high motivational abilities are more likely to adopt
health behaviors such as physical activity and adequate diet (Schwarzer, 1999; Tangney et al., 2004) that reduce cardiovascular risk factors (Anderson, Konz, & Jenkins, 2000; Mensink, Ziese, & Kok, 1999) known to be involved in the pathogenesis and progression of AD (Kivipelto et al., 2001; Launer, 2002; Zhu et al., 2007). In terms of cognitive training, individuals with high motivational abilities show better learning behavior (Orbell, 2003) and educational and occupational attainment (Luszczynska, Diehl, Gutiérrez Doña, Kuusinen, & Schwarzer, 2004; Tangney et al., 2004). MR facilitates mental training throughout life and may be important in establishing a CR. In terms of emotional health, motivational abilities reduce the risk of depression and anxiety, as reported above, which are in turn associated with an increased risk of subsequent dementia (Jorm, 2000b; Ownby, Crocco, Acevedo, John, & Loewenstein, 2006) and an increase in AD-related neuropathological changes within the hippocampus (Rapp et al., 2006). These last basic processes are not, however, focus of the present empirical investigation.

The Present Study

The present study was designed to examine the effects of lifetime motivational and cognitive abilities in predicting cognitive status and mild cognitive impairment in old age (see Figure 1). We use a sample of 147 elderly individuals without dementia. A rating procedure based on the participants’ occupational history was used to approximate midlife motivational and cognitive abilities. Because the DOT has serious flaws (see Methods section), we applied the Occupational Information Network (O*NET, Peterson, Mumford, Borman, Jeanneret, & Fleishman, 1999; Peterson et al., 2001) to code the participants’ occupations and to estimate their midlife abilities.

The first goal of the study was to use theoretical and empirical criteria to select O*NET variables to estimate participants’ motivational and cognitive abilities. In a first step, variables were selected on the basis of their descriptions. In a second step, these variables
were correlated with established self-report measures of motivational abilities and a measure of crystallized intelligence often used to estimate former intelligence. Only those variables that were primarily associated with motivational abilities and those variables that were primarily associated with cognitive abilities were selected for further analyses. This approach represents a major advance for measures based on occupational data: previous DOT constructs such as “occupational demands” and “complexity of work” were too global for effects to be attributed to specific abilities.

The second goal was to predict current cognitive status and odds of mild cognitive impairment by these O*NET variables. On the basis of previous research, we predicted that both motivational and cognitive abilities would be independently associated with current cognitive status and odds of mild cognitive impairment. Additionally, we assessed whether psychological wellbeing could be predicted by both motivational and cognitive abilities. Motivational ability was expected to be the stronger predictor of psychological wellbeing.

Method

Participants

A total of 147 adults, ranging in age from 60 to 94 years, participated in the study. The data of two participants were incomplete due to visual impairment. All participants were healthy, community-dwelling individuals recruited from the greater Zurich area, Switzerland, via the University for Seniors (a weekly event for individuals aged 65 and older), old people’s homes, and an advertisement in a magazine for seniors. Subjects participated voluntarily after receiving oral or written information about the study. The study population was stratified for age group (60-69, 70-79, 80+), sex, and education (< vs. ≥ 13 years).

Procedure

Participants completed a comprehensive questionnaire and cognitive tests. The questionnaire elicited a detailed description of the occupational history and contained self-
report measures of motivational abilities and psychological wellbeing. All cognitive tests were administered during a 60-90 minute session either at the University or in the participant’s home. The questionnaire was sent to participants via mail at least one week before the test session. Participants completed the questionnaires on their own, but were told that assistance was available if necessary.

The cognitive test battery, which was administered by graduate students with training in neuropsychological assessment, took place in a comfortable room. The tasks were administered to all participants in the same order. Participants signed a consent form and were given a neuropsychological report on their performance. In addition to their travel expenses, participants received a magazine, sweet or salty snacks, and 10 Swiss franks (approx. US$ 8.30) as compensation for their time.

*O*NET-Estimated Midlife Motivational and Cognitive Abilities

The main predictors in the study were motivational and cognitive abilities estimated by reference to a sample of Occupational Information Network (O*NET) variables on the basis of each participant’s main occupation. The O*NET is the official occupational classification system of the US Department of labor (Peterson et al., 1999; Peterson et al., 2001). It consists of a hierarchically structured lexicon of occupations and a large database of work and worker characteristics associated with each job. The O*NET is the result of a large-scale research project sponsored by the US Department of Labor over recent decades.

To provide a context for understanding the O*NET and its application in this study, we briefly review the Dictionary of Occupational Titles (DOT, US Department of Labor, 1991), the predecessor of the O*NET. The DOT provides descriptive information on over 12,000 jobs. Beginning in the 1930s, one or two trained occupational analysts interviewed and observed workers, and then rated characteristics of their occupation, such as worker functions and demands. Over the years, a number of limitations of the DOT have become
apparent (Cain & Treiman, 1981; Peterson et al., 2001): The information contained in the DOT was becoming dated. New tasks had been generated for each new job, but without a cross-job organizing structure it was difficult to compare similarities and differences across jobs. More importantly, the DOT did not directly provide a great deal of information on the abilities required to perform the jobs listed.

These and more shortcomings of the DOT led to the development of the O*NET (Peterson et al., 1999; Peterson et al., 2001). The number of occupations was reduced to about 1,100. The O*NET database is structured according to a “content model” that classifies variables within six domains: worker characteristics (abilities, occupational interests, work values, work styles), worker requirements (skills, knowledge, education), experience requirements (training, entry requirements, licensing), occupational requirements (work activities, work context), occupation-specific information, and workforce characteristics. In the O*NET data collection program, questionnaires were used to assess samples of workers in each job with respect to these variables. For the goal orientation variable, for example, workers were asked: “How important is organizing, planning, and prioritizing work (i.e., developing specific goals and plans to prioritize, organize, and accomplish your work) to the performance of your current job?” The workers responded on a 5-point scale.

Each new version of the O*NET represents an update of these data. The current version 12.0 released in June 2007, which is used in this study, is based on samples of $n = 20$ to 70 incumbents per occupation. Initial analyses showed that most O*NET variables regarding skills, abilities, and work activities were reliable and valid (Peterson et al., 1999). In a limited set of frequent occupations, incumbents (mean $n = 18$) and analysts rated the importance of O*NET worker characteristics. For the incumbents, most inter-rater reliability coefficients were in the .70s and .80s. If 30 incumbents were available, inter-rater coefficients in the high .80s or low .90s were obtained. Most correlations with expert ratings were in the
.70s and .80s, indicating substantial agreement in the descriptions of occupational skill requirements. Note that this study used the first version of the O*NET; even higher reliability and validity coefficients can be expected for the current version, which is based on a much higher number of incumbents.

**Assessment of main job.** In the present study, the participants were asked to name the occupations they held (a) in the first job they held for at least 1 year after finishing education, (b) in their four longest held jobs, and (c) in the last job of their professional life. For each job, data were collected on the start and finish dates, job title, and major activities and duties. If data regarding dates, work activities, and duties were missing, participants were asked to add this information at the beginning of the cognitive test sessions. Only data on the main (longest) occupation were processed any further.

**Coding of main job.** O*NET occupational codes were assigned on the basis of the main occupation. Information on participants’ major activities and duties is crucial for their coding to O*NET occupations. The coders compared the activities and duties the participant indicated with those provided for each O*NET occupation. The occupation exhibiting the best match was selected. The O*NET procedure is thus also largely applicable to Swiss occupations.

Each participant’s occupational information was coded independently by two coders; any coding differences were reconciled in discussion with the first author. When a disagreement was found, the participant’s answers and the O*NET job descriptions were reexamined and the coding was discussed until a majority consensus was reached. Initial interrater agreement was 80% at the highest level of aggregation (2 digits), 60% at the second highest level (3 digits), and 45% at the lowest level of the detailed O*NET occupations (8 digits). Participants who had been housewives for the longest period were classified
according to their second-longest held job. Three subjects who had been housewives all their lives were coded as “personal and home care aides.”

Selection of O*NET variables. Once an individual’s main job had been coded, all O*NET variable values belonging to this O*NET occupation were assigned to the participant. The few variables that are able to measure motivational and cognitive abilities were selected in two steps: on the basis of (1) their content validity and (2) their correlations with self-reported motivational abilities and a measure of crystallized intelligence. Because the use of theoretical and empirical criteria to select O*NET variables was one of the aims of this study, we present the outcomes of this procedure in the Results.

Self-Reported Motivational Abilities

Four self-report scales were used to assess motivational abilities.

Motivation and decision regulation. Two five-item scales of the Volitional Components Questionnaire (VCQ, Kuhl & Fuhrmann, 1998) in its German version were used to assess motivation regulation (e.g., “I can usually motivate myself quite well if my determination to persevere weakens.”) and decision regulation (e.g., “When I think about doing or not doing something, I usually arrive at a decision quickly.”). Participants rated their agreement with each statement on a 4-point scale. The alpha coefficient was 0.76 for motivation regulation and 0.71 for decision regulation. The validity of the two VCQ scales is supported by studies showing that scores on these scales predict the enactment of difficult intentions in various settings, including therapy (Forstmeier & Rüddel, 2007), management training (Kehr, Bles, & von Rosenstiel, 1999), and study behaviour (Orbell, 2003). The VCQ scales are also meaningfully associated with other measures of self-regulation and self-efficacy (Sellin, Schütz, Kruglanski, & Higgins, 2003) and psychological wellbeing (Kuhl & Fuhrmann, 1998).
Activation regulation. We used the locomotion scale of the Locomotion and Assessment Questionnaire (LAQ, Kruglanski et al., 2000) in its German version (Sellin et al., 2003) to measure activation regulation. The scale consists of 10 statements regarding activating oneself or starting with an action (e.g., “When I decide to do something, I can't wait to get started.”). Participants rated their agreement with each item on a 6-point scale. The alpha coefficient was 0.64. The validity of the locomotion scale is supported by significant correlations with measures of action control, motivational self-regulation, self-control, self-efficacy beliefs, and psychological wellbeing (Kruglanski et al., 2000; Sellin et al., 2003).

General self-efficacy. The General Self-Efficacy scale (GSE, Scholz, Gutierrez Dona, Sud, & Schwarzer, 2002) in its German version (Schwarzer, 1994) was used to assess the “broad and stable sense of personal competence to deal effectively with a variety of stressful situations” (Scholz et al., 2002, p. 243). Participants rated 10 items (e.g., “I am confident that I could deal efficiently with unexpected events.”) on a 4-point scale. The alpha coefficient was 0.86. Meaningful associations with goal setting, action planning, motivational self-regulation, and psychological wellbeing attest to the validity of the GSE (Luszczynska et al., 2005).

To minimize floor and ceiling artifacts and other forms of measurement error, we performed the analyses on composite measures rather than on individual tests. The composite measure of motivational abilities was constructed by converting the component tests to z scores, using the baseline mean and SD of all study participants, and averaging the z scores.

Assessment of Crystallized Intelligence

A German vocabulary test (Wortschatzttest, WST, Schmidt & Metzler, 1992) was used to assess crystallized intelligence (or knowledge). The test consists of 42 lines of six words. One of the words in each line is real; five are nonsense. The participants are asked to identify
the real word in each line. Difficulty increases from line to line. The WST has been shown to estimate former (premorbid) IQ (Lehrl, Triebig, & Fischer, 1995).

Assessment of Current Cognitive Status

Current cognitive status was assessed by means of five cognitive performance tests.

Processing speed. The Digit Symbol Substitution Test (DSST) of the Wechsler Adult Intelligence Scale-III (WAIS-III, Wechsler, 1997) assesses visual-motor speed. Participants were asked to match as many digits as possible to a set of corresponding symbols in 120 s.

Working Memory. The Digit Span Forward and Backward WAIS-III subtests were used to assess working memory (Wechsler, 1997). In the Digit Span Forward subtest, participants repeated sequences of 3–9 digits; in the Digit Span Backward subtest, they recalled sequences of 2–8 digits in reverse order.

Verbal Fluency was assessed with the Animal Naming Task (Morris et al., 1989). Participants were asked to name as many different animals as possible in 60 s.

Inhibition of prepotent responses. The Stroop Color-Word Test (SCWT, Stroop, 1935) was used to measure this subcomponent of executive function. Participants were asked to read aloud or name the stimuli on each card (color names on card 1, color of the patches on card 2, and color of the ink on card 3) one after the other as quickly as possible but without making errors. Ability to inhibit prepotent responses was calculated by subtracting time to read card 2 from time needed to name the color of the ink of card 3.

Again, we constructed a composite measure of global cognition after converting the component tests to z scores and averaging them.

Assessment of Current Psychological Wellbeing

Current psychological wellbeing was assessed with six scales, half of them positive (positive affect, satisfaction with life, self-esteem) and half of them negative (negative affect,
depression, anxiety). A composite measure was created using the average of the $z$ scores of the six scales (after reversing the negative scales).

*Positive and negative affect.* General affectivity was assessed using the Positive and Negative Affect Schedule (PANAS, Watson, Clark, & Tellegen, 1988). The schedule lists 20 adjectives, each of which is rated on a 5-point scale. Ten items form the positive affect scale (e.g., enthusiastic, excited, active) and 10 the negative affect scale (e.g., upset, afraid). Participants were asked to think about how they were feeling in general. Ratings were averaged to generate positive and negative affect scores. The alpha coefficient was 0.81 for positive and 0.85 for negative affect.

*Satisfaction with life* was assessed with the Satisfaction With Life Scale (SWLS, Diener, Emmons, Larsen, & Griffin, 1985). The SWLS is a five-item measure of overall life satisfaction, with higher scores indicating greater life satisfaction. The alpha coefficient was 0.80.

*Self-esteem.* We used Rosenberg’s Self-Esteem Scale (RSE, Rosenberg, 1965) to measure global self-esteem. This questionnaire consists of 10 statements reflecting global attitudes about the self (e.g., “I feel that I'm a person of worth at least on an equal plane with others”). Participants rated their agreement with each item on a 4-point scale. The alpha coefficient was 0.77.

*Depression.* Depression was assessed with the Geriatric Depression Scale (GDS, Yesavage et al., 1983), which is widely used in geriatric research. We used the 15-item version with a yes/no answer format. The alpha coefficient was 0.72.

*Anxiety.* We used the six-item anxiety subscale of the Brief Symptom Inventory (BSI, Derogatis, 1993) to assess anxiety. Participants rated their agreement with each item on a 5-point scale. Alpha coefficient was 0.68.
Other Variables

Education. Participants were asked for their highest level of education. Individuals with a university (master’s) degree will be coded as having completed 18 years of education, and participants with a PhD or MD as having completed 21 years, regardless of actual years in school.

Perceived stress. The Perceived Stress Scale (PSS, Cohen, Kamarck, & Mermelstein, 1983) measures the degree to which the current life situation (past month) is considered stressful. This 10-item scale is widely used in stress research. Participants rate the frequency of unpredictable, uncontrollable, and overwhelming events on a 5-point scale. The alpha coefficient was 0.83.

Statistical Analyses

Bivariate correlations were calculated to explore bivariate relationships among all variables. The O*NET variables that correlated significantly with the global measure of motivational ability but not with the vocabulary test were selected for the O*NET motivational ability score. Likewise, the O*NET variables that correlated significantly with the vocabulary test but not with the global measure of motivational abilities were selected for the O*NET cognitive ability score.

Two hierarchical multiple regression analyses were used to examine how the O*NET motivational and cognitive abilities related to current cognitive status and psychological wellbeing. In both regression analyses, O*NET motivational abilities was entered in step 1, four control variables (age, sex, education, and intelligence) were entered in step 2, and O*NET cognitive abilities, current stress level, and their interactions with O*NET motivational abilities were entered in step 3. Age and education were entered as continuous variables.
To analyze the relationship between O*NET global scores and mild cognitive impairment, participants scoring $\geq 1$ SD below the mean of the composite measure of global cognition were defined as impaired. To evaluate the relative risk of mild cognitive impairment associated with O*NET motivational and cognitive abilities, we used multiple logistic regression to calculate the odds ratio (OR) and 95% confidence intervals. An OR less than 1 would indicate a reduced risk of mild cognitive impairment, an OR greater than 1 would indicate an increased risk. The variables were entered in three steps analogous to the multiple regression analyses. For exploratory purposes, all regression analyses were performed a second time with self-reported current motivational abilities as an additional predictor.

Results

Sample Characteristics

Characteristics of the sample and descriptive data at baseline are given in Table 1. The 147 participants had a mean age of 74 years (age range 60-94) and a mean duration of education of 13.6 years. Sixty percent were women. Almost half lived with a partner or other persons, 29% lived alone, and 22% in old people’s homes. Fourteen individuals (9.5%) were classified as cognitively impaired, two thirds of them living in old people’s homes (6.1%). In terms of the O*NET major occupational groups, the largest group (31%) had worked in office and administrative support occupations; 16% in management occupations; 12% in education, training, and library occupations; 8% in healthcare and technical occupations; 5% in sales and related occupations; and less than 5% in each of the other occupational groups.

O*NET Variables, Self-Reported Motivational Ability, and the Vocabulary Test

Examining the content of all O*NET variables, we identified 31 variables that referred to motivational abilities and 44 that referred to cognitive abilities. However, empirical correlations with established measures were considered to be crucial for the final
selection of variables. Two variables were significantly associated with self-reported motivational abilities but not with intelligence (see Table 2): goal orientation (item 4.A.2.b.6; “developing specific goals and plans to prioritize, organize, and accomplish your work”) and action planning (4.A.1.b.3; “determining time, costs, resources, or materials needed to perform a work activity”). Four variables were significantly correlated with intelligence but not with self-reported motivational abilities: selective attention (1.A.1.g.1; “ability to concentrate on a task over a period of time without being distracted”), recognizing problems (1.A.1.b.3; “ability to tell when something is wrong or is likely to go wrong”), assessing performance (2.A.2.d; “assessing performance of yourself, other individuals, or organizations to make improvements”), and social perceptiveness (2.B.1.a; “being aware of others’ reactions and understanding why they react as they do”).

A composite for midlife motivational abilities (i.e., motivational reserve) was constructed based on the $z$-standardized scores of goal orientation and action planning. Likewise, a composite for midlife cognitive abilities (i.e., cognitive reserve) was constructed based on the $z$-standardized scores of the four cognitive variables. Internal consistency (alpha) was 0.64 for the O*NET motivational abilities total score and 0.82 for the O*NET cognitive abilities total score. The two total scores were used in the following analyses.

**Prediction of Current Cognitive Status**

The bivariate correlations show that O*NET motivational abilities, but not O*NET cognitive abilities were significantly associated with the current cognitive status (Table 2). Results of the hierarchical multiple regression analyses for current cognitive status are summarized in Table 3. O*NET motivational abilities were related to higher cognitive status, even when age, sex, education, and intelligence were controlled (model 2). When also O*NET cognitive abilities, the current stress level, and their interaction with motivational abilities were taken into account, O*NET motivational abilities was still a significant
predictor of current cognitive function (model 3). Crystallized intelligence (vocabulary test) was highly associated with current cognitive status (models 2 and 3) and did not weaken the correlation of O*NET motivational abilities and current cognitive status. However, O*NET cognitive abilities did not predict current cognitive status. The influence of current stress level on current cognition almost reached significance. Finally, age was a significant predictor of current cognitive function.

When self-reported current motivational abilities were included in the regression analysis, O*NET motivational abilities were still a significant predictor of current cognitive function ($\beta = .21, p = .01$), as was crystallized intelligence ($\beta = .37, p < .001$).

Neither the interaction of O*NET motivational abilities with cognitive abilities nor with current stress level was significant. However, in a multiple regression analysis with only O*NET motivational and cognitive abilities and their interaction as predictors (without control variables), the interaction almost reached significance ($\beta = -0.15; t = -1.85; p = 0.07$). The same was found for perceived stress: In a multiple regression analysis with motivational abilities, stress level, and their interaction, the interaction almost reached significance ($\beta = -0.14; t = -1.76; p = 0.08$).

*Prediction of Current Psychological Wellbeing*

The bivariate correlations reveal that O*NET motivational abilities, but not O*NET cognitive abilities were significantly associated with current psychological wellbeing (Table 2). Table 3 shows the results of the hierarchical multiple regression analyses for current psychological wellbeing. O*NET motivational abilities were related to higher cognitive status in all models. Neither O*NET cognitive abilities nor the vocabulary test predicted wellbeing. The current perceived stress level was highly predictive of current emotional wellbeing.
When self-reported current motivational abilities were included in the regression analysis, O*NET motivational abilities no longer significantly predicted current wellbeing ($\beta = .11, p = .13$), but self-reported motivational abilities did ($\beta = .21, p < .01$). Given that the concept of MR concerns resilience against cognitive (not affective) decline, this result does not cast doubt on our conclusions, but is an interesting indication that midlife and current motivational abilities are differentially associated with cognitive and affective status.

Again, both interactions were not significant. However, in a multiple regression analysis with only O*NET motivational and cognitive abilities and their interaction as predictors (without control variables), the interaction almost reached significance ($\beta = -0.15; t = -1.83; p = 0.07$). The same was observed for the interaction with perceived stress ($\beta = -0.13; t = -1.70; p = 0.09$).

Prediction of Risk of Mild Cognitive Impairment

Results of the logistic regression analyses exploring the associations between odds of mild cognitive impairment and O*NET motivational and cognitive abilities are summarized in Table 4. O*NET motivational abilities were associated with reduced odds of mild cognitive impairment in all models, even when we controlled for age, sex, education, and intelligence (model 2), as well as O*NET cognitive abilities and current stress level (model 3). O*NET cognitive abilities was not associated with reduced odds of mild cognitive impairment. Finally, age and intelligence as measured with the vocabulary test were associated with reduced odds of mild cognitive impairment (models 2 and 3).

When self-reported current motivational abilities were included in the regression analysis, O*NET motivational abilities were still associated with reduced odds of mild cognitive impairment (OR .13; 95% CI .03-.50), as was crystallized intelligence (OR .72; 95% CI .58-.89).
Discussion

The main aim of this study was to empirically examine the motivational reserve concept. As expected, our results revealed that midlife motivational abilities predicted cognitive status, odds of mild cognitive impairment, and psychological wellbeing, even when age, sex, education, and cognitive ability were controlled. In comparison, O*NET-estimated cognitive abilities did not emerge to be a significant predictor of the three outcome variables. However the vocabulary test used as a measure of crystallized intelligence, which does not decline with age, proved to be a good predictor of current cognitive status and of odds of mild cognitive impairment, but not of psychological wellbeing.

In addition, this study aimed at identifying O*NET variables suitable for estimating motivational and cognitive abilities. Based on content validity and on correlations with self-reported motivational abilities and a measure of crystallized intelligence, two motivational and four cognitive items were selected. This procedure ensured that the two global scores computed were independent measures of individual motivational and cognitive abilities. This approach represents a major advance for measures based on occupational data: previous DOT constructs, such as “occupational demands” and “complexity of work,” were too global for effects to be attributed to specific abilities (e.g., Andel et al., 2007; Smyth et al., 2004).

Motivational and Cognitive Abilities as Predictors

Our results provide further evidence that motivational abilities throughout life are associated with cognitive aging and odds of cognitive impairment, and that midlife motivational abilities can provide a motivational reserve against cognitive impairment (see Figure 1). It was shown previously that self-efficacy beliefs predict academic performance (Luszczynska et al., 2005) and memory performance in older people (Valentijn et al., 2006). Our results are also in line with case-control studies that found indicators of motivational self-regulation to be inversely associated with cognitive impairment and AD, with self-
directed occupational conditions increasing intellectual functioning in older workers (Schooler et al., 2004) and high control possibilities at work decreasing the risk of AD (Seidler et al., 2004).

The participants in our study were on average aged 44 years (range 20-60) in the middle of their main occupation. Thus, our measure of midlife motivational abilities refers essentially to the midlife of most individuals, many years before a possible Alzheimer’s neuropathy would be manifest in cognitive performance.

The vocabulary test as a measure of crystallized intelligence and an estimate of midlife intelligence was, as predicted, associated with current cognitive status and odds of mild cognitive impairment. This finding is in line with the results of other studies using premorbid cognitive tests as predictors of cognitive impairment (Corral et al., 2006) and incidence of AD (Schmand, Smit, Geerlings, & Lindeboom, 1997; Whalley et al., 2000). However, the O*NET cognitive abilities global score, which correlated significantly with the vocabulary test, did not significantly predict current cognitive function. One reason might be the smaller variance of the O*NET cognitive score relative to the vocabulary test. Furthermore, the O*NET cognitive score may be affected by more non-cognitive factors than the vocabulary test (e.g., social skills, which were not controlled in our study). As a behavioral measure, the vocabulary test is a more reliable instrument than the O*NET variables, which represent averages of self-report measures.

In conclusion, exercising cognitive abilities throughout life is known to act as a buffer against cognitive decline in old age (Hultsch, Hertzog, Small, & Dixon, 1999). Moreover, various studies have shown that physical activities (Podewils et al., 2005) and social as well as leisure activities (Crowe, Andel, Pedersen, Johansson, & Gatz, 2003) are related with a lower risk of dementia. Motivational abilities are difficult to observe directly, but are probably involved in many such activities. For example, individuals use motivational abilities
to build and maintain the necessary motivation to engage in regular physical activity. Karp et al. (2005) tried to estimate the mental, physical, and social components of each activity and found that it seems to be more beneficial to engage in activities covering more than one of the components than in just one type of activity. Future studies investigating activities and cognitive aging might include an assessment of the motivational components of each activity.

Emotional health was only predicted by motivational abilities in this study. A host of previous studies attest to the role of motivational self-regulation and self-concept. For example, motivational abilities have been shown to predict depression in a prospective study (Rholes et al., 1989), to correlate with fewer reports of anxiety and depression (Kruglanski et al., 2000; Luszczynska et al., 2004; Tangney et al., 2004) and with wellbeing in general (Bandura, 1997).

O*NET cognitive abilities and current stress level were expected in our model to be moderators of the association between MR and current cognitive status and emotional wellbeing (see Figure 1). This has not been confirmed in this study. The lack of significance of the interactions cannot be accredited to age and/or intelligence as stronger predictors, because the interactions were not significant even when the control variables were removed from the analysis. These results suggest that motivational reserve appears to be a rather independent predictor of cognitive and emotional health.

Use of O*NET in Psychological Research

The O*NET system was used for the first time to separately estimate motivational and cognitive abilities. Correlation analysis was applied to support the validity of the O*NET-based measures. One previous study found the O*NET variable “autonomy” to be negatively related to the number of doctor visits and absence from work, but not to self-reported wellbeing (Liu et al., 2005). Although this variable can, theoretically, be numbered among the motivational abilities, our data show that it significantly correlates with both self-reported
motivation and intelligence. It therefore seems to be a multifaceted item. Other studies have used “complexity of work,” a very global construct comprising cognitive, motivational, and social items, that has been shown to correlate with a self-report measure of job complexity (Shaw & Gupta, 2004). Although some studies have found global O*NET scores comprising cognitive, motivational, and social items to correlate with performance in cognitive tests (Jeanneret & Strong, 2003), our data suggest that such applications should be subjected to careful empirical validation. In summary, the advantages of using our approach is to provide higher specificity of O*NET-based measures, the possibility to assess the validity of these measures, and the potential to make more specific predictions.

The use of the O*NET in psychological research rests on the supposition that O*NET work and worker characteristics collected from a sample of worker (\( n = 20-70 \)) in each job applies largely to all individuals working in that job. We assume a reciprocal relationship. Individuals with certain motivational and cognitive skills gravitate toward occupations needing these skills. Conversely, working in a job with certain psychological demands for most of one’s working life affects one’s abilities. Clearly, individuals can be overqualified - in the sense of having skills in excess of those required to perform the tasks associated with the job - or they can be under-qualified. Although both are possible, models of job design and recruitment (Albrecht & Vroman, 2002) and empirical data (Wilk, Desmarais, & Sackett, 1995) assume that exceptions to positive assortative matching are of minor importance. However, one must bear in mind that our measures of midlife motivational and cognitive abilities are only estimates based on groups of workers and that they provide only inferential characterizations of a particular individual.

Limitations and Conclusions

Several limitations of this study must be considered. First, it is cross-sectional in design and can thus only reveal the effect of age and not the effect of aging.
studies are needed to further-reaching hypotheses, such as the association of O*NET motivational abilities and cognitive decline or conversion from mild cognitive impairment (MCI) to dementia. As a second, related point, most of the older people in the present community-based sample were largely healthy. Future studies could include patients with dementia, depression, or other psychiatric disorders to investigate how the O*NET-based measures relate to disease processes.

Third, the procedure used to determine mild cognitive impairment could be seen as a limitation of the study. Our definition of mild cognitive impairment was based solely on the composite measure of global cognition, with a selection criterion set at $\geq 1$ SD below the mean. This is certainly not as precise a definition as, for example, the diagnostic criteria for MCI (Petersen, 2004). Future studies investigating motivational reserve and cognitive impairment should apply established criteria of MCI and/or dementia.

Fourth, we did not include covariates such as APOE 4 status, vascular risk factors, and lifestyle factors such as smoking and drinking. Nevertheless, our approach is comparable with most studies in this field of research, which also use only age, sex, and education.

Fifth, initial interrater agreement on the classification of occupations was quite low at the most detailed level of aggregation (45%), but high at the highest level of aggregation (80%). In a review of interrater agreement for occupations, Mannetje and Kromhout (2003) documented a similar pattern in several studies: the higher the level of aggregation, the better the agreement rates. Although an agreement of 45% is rather low, previous studies have shown that such findings are to be expected at the most detailed eight-digit level (Kromhout & Vermeulen, 2001). Future studies using the O*NET system should ensure that coders are given more intensive training, because clear instruction on decision-making, familiarity with the classification, and regular feedback on coding errors can improve reliability by 20% (Kromhout & Vermeulen, 2001).
Finally, the O*NET system provides the researcher with a huge database allowing various other constructs, such as physical activities and social contacts, to be estimated by O*NET variables. Future studies could profitably draw on other O*NET-based measures in addition to motivational and cognitive aspects.

Despite these limitations, the present results provide preliminary support for the concept of motivational reserve and the idea that midlife motivational abilities may be associated with a risk of cognitive impairment. This line of research may eventually contribute to our understanding of the long-term effects of motivational dysfunction on cognition, MCI, and dementia in older age. It might help to identify those at greatest risk of cognitive impairment and dementia in later life. The presence of apathy, a symptom of motivational dysfunction, increases the risk of conversion from MCI to AD (Robert et al., 2006). The relationship between midlife motivational abilities and presence of apathy has yet to be investigated. More importantly, motivational abilities are potentially modifiable risk factors of cognitive impairment (Forstmeier & Rüddel, 2007; Levine et al., 2007). Motivational skills training could be incorporated into established psychotherapy strategies with older people (Forstmeier & Maercker, 2007b; Maercker, 2002). Clinical trials are needed to assess the effectiveness of prevention and early treatment interventions targeting emotional and cognitive health.
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Footnotes

1 In terms of published norm values of the four tests we used to assess cognitive status (digit symbol, digit span, verbal fluency, Stroop), 2 of the 14 “mildly impaired” individuals had normal values in all four tests, 7 had values more than 1 SD below the mean of the norm population in one of the four tests, 5 had lower values in two tests, and none had lower values in three or four tests. Most often, working memory (digit span) or verbal fluency was impaired. This pattern shows a slight impairment in single cognitive domains, whereas other domains were preserved. It is possible that self-report data might be affected by this mild cognitive impairment. However, the main variables in this study do not rely on self-report measures. It was never necessary to ask the informant about the participant’s occupations.

2 Given the high percentage of “office and administration occupations”, the question arises as to whether the sample is positively selected. The sample would indeed be positively selected if O*NET-based MR was exceptionally high in this occupational category. However, this is not the case. The mean MR value of the office and administration occupations was -0.19, slightly below the overall mean MR (see Table 1).
Table 1

Baseline Characteristics of the Sample by Age Group (N = 147)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total</th>
<th>60-69</th>
<th>70-79</th>
<th>80+</th>
<th>F / χ² value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years), M (SD)</td>
<td>73.9 (8.0)</td>
<td>65.2 (2.6)</td>
<td>75.0 (3.1)</td>
<td>84.2 (3.4)</td>
<td>434.9***</td>
</tr>
<tr>
<td>Sex (% female)</td>
<td>60.5</td>
<td>23.1</td>
<td>21.8</td>
<td>15.6</td>
<td>1.0</td>
</tr>
<tr>
<td>Education (years), M (SD)</td>
<td>13.6 (2.6)</td>
<td>14.2 (2.5)</td>
<td>13.2 (2.6)</td>
<td>13.1 (2.5)</td>
<td>2.9</td>
</tr>
</tbody>
</table>

Sex distribution by age and education categories

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<thead>
<tr>
<th>Education &lt; 13 years</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>0.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female (n)</td>
<td>51</td>
<td>17</td>
<td>21</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Male (n)</td>
<td>24</td>
<td>7</td>
<td>11</td>
<td>6</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Education &gt;= 13 years</th>
<th></th>
<th></th>
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<th></th>
<th>1.5</th>
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</thead>
<tbody>
<tr>
<td>Female (n)</td>
<td>38</td>
<td>17</td>
<td>11</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Male (n)</td>
<td>34</td>
<td>11</td>
<td>14</td>
<td>9</td>
<td></td>
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</tbody>
</table>

Living situation

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>64.2***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single, at home (%)</td>
<td>29.3</td>
<td>16.3</td>
<td>6.8</td>
<td>6.1</td>
<td></td>
</tr>
<tr>
<td>With partner (%)</td>
<td>46.3</td>
<td>18.4</td>
<td>24.5</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>With family member (%)</td>
<td>1.4</td>
<td>0.7</td>
<td>0.7</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Old people’s home (%)</td>
<td>22.4</td>
<td>0.0</td>
<td>6.1</td>
<td>16.3</td>
<td></td>
</tr>
<tr>
<td>With other persons (%)</td>
<td>0.7</td>
<td>0.0</td>
<td>0.7</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>

Motivational abilities, M (SD)

<p>| | | | | | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Motivation regulation (VCQ)</td>
<td>8.5 (2.3)</td>
<td>8.5 (2.7)</td>
<td>8.4 (2.1)</td>
<td>8.6 (2.2)</td>
<td>0.1</td>
</tr>
<tr>
<td>Decision regulation (VCQ)</td>
<td>10.3 (2.4)</td>
<td>10.2 (2.8)</td>
<td>10.5 (2.3)</td>
<td>10.0 (2.1)</td>
<td>0.5</td>
</tr>
<tr>
<td>Activation regulation (LAQ)</td>
<td>47.7 (6.4)</td>
<td>47.9 (6.4)</td>
<td>48.3 (6.2)</td>
<td>46.5 (6.7)</td>
<td>0.9</td>
</tr>
<tr>
<td>General self-efficacy (GSE)</td>
<td>28.2 (4.2)</td>
<td>28.4 (4.5)</td>
<td>28.7 (4.1)</td>
<td>27.3 (3.8)</td>
<td>1.3</td>
</tr>
<tr>
<td>Former intelligence (WST)</td>
<td>34.1 (4.2)</td>
<td>35.1 (4.2)</td>
<td>34.0 (3.4)</td>
<td>32.8 (5.1)</td>
<td>3.4*</td>
</tr>
<tr>
<td>Cognitive impairment, n (%)</td>
<td>14 (9.5)</td>
<td>0</td>
<td>4 (2.7)</td>
<td>10 (6.8)</td>
<td>18.2***</td>
</tr>
</tbody>
</table>

Current cognitive status
<table>
<thead>
<tr>
<th></th>
<th>Digit Symbol Test</th>
<th>Digit Span Forward</th>
<th>Digit Span Backward</th>
<th>Verbal Fluency</th>
<th>Stroop Color-Word Test</th>
<th>Current psychological wellbeing</th>
<th>O*NET Composite measures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>52.0 (15.0)</td>
<td>61.1 (12.1)</td>
<td>50.5 (12.9)</td>
<td>25.3***</td>
<td>22.6 (14.4)</td>
<td>Positive affect (PANAS)</td>
<td>0.01 (0.9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Negative affect (PANAS)</td>
<td>0.04 (0.8)</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>Satisfaction with life (SWLS)</td>
<td>0.08 (0.8)</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Self-esteem (RSE)</td>
<td>-0.13 (1.0)</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Depressive symptoms (GDS)</td>
<td>0.00 (0.8)</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>Anxiety (BSI)</td>
<td>0.03 (0.9)</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Perceived Stress (PSS)</td>
<td>0.10 (0.7)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>O*NET Motivational abilities</td>
<td>-0.18 (0.9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>O*NET Cognitive abilities</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Note. VCQ = Volitional Components Questionnaire; LAQ = Locomotion and Assessment Questionnaire (locomotion scale); GSE = General Self-Efficacy scale; WST = Wortschatztest (German Vocabulary Test); PANAS = Positive and Negative Affect Schedule; SWLS = Satisfaction With Life Scale; RSE = Rosenberg's Self-Esteem Scale; GDS = Geriatric Depression Scale; BSI = Anxiety subscale of the Brief Symptom Inventory; PSS = Perceived Stress Scale.</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>a Average of z scores.</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>* p &lt; .05. ** p &lt; .01. *** p &lt; .001.</td>
<td></td>
</tr>
</tbody>
</table>
Table 2

*Bivariate Correlations between O*NET Variables and Self-Reported Motivational Ability, Former Intelligence, Current Cognitive Status and Wellbeing (N = 147)*

<table>
<thead>
<tr>
<th>O*NET variables</th>
<th>Self-reported motivational ability&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Former intelligence&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Current cognitive status&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Current psychological wellbeing&lt;sup&gt;d&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>O*NET motivational abilities - Total</td>
<td>0.32**</td>
<td>0.12</td>
<td>.20*</td>
<td>.28*</td>
</tr>
<tr>
<td>Goal orientation</td>
<td>0.30**</td>
<td>0.17</td>
<td>.23**</td>
<td>.27**</td>
</tr>
<tr>
<td>Action planning</td>
<td>0.26**</td>
<td>0.03</td>
<td>.11</td>
<td>.21*</td>
</tr>
<tr>
<td>O*NET cognitive abilities - Total</td>
<td>0.12</td>
<td>0.31**</td>
<td>.13</td>
<td>.09</td>
</tr>
<tr>
<td>Selective attention</td>
<td>0.11</td>
<td>0.28**</td>
<td>.09</td>
<td>.06</td>
</tr>
<tr>
<td>Recognizing problems</td>
<td>0.11</td>
<td>0.21**</td>
<td>.06</td>
<td>.05</td>
</tr>
<tr>
<td>Assessing performance</td>
<td>0.11</td>
<td>0.26**</td>
<td>.19*</td>
<td>.11</td>
</tr>
<tr>
<td>Social perceptiveness</td>
<td>0.07</td>
<td>0.26**</td>
<td>.10</td>
<td>.10</td>
</tr>
</tbody>
</table>

*Note.*<sup>a</sup> Average of z scores for motivation and decision regulation (VCQ), activation regulation (LAQ), and general self-efficacy (GSE).<sup>b</sup> German Vocabulary Test (WST).<sup>c</sup> Average of z scores for processing speed (DSST), working memory (digit span), verbal fluency, and inhibition (SCWT).<sup>d</sup> Average of z scores for positive and negative affect (PANAS), satisfaction with life (SWLS), self-esteem (RSE), depression (GDS), and anxiety (BSI).

* p < .05. ** p < .01.
Table 3

**Summary of Separate Multiple Hierarchical Regression Analyses Predicting Current Cognitive Status and Psychological Wellbeing (N = 147)**

<table>
<thead>
<tr>
<th></th>
<th>Current cognitive status</th>
<th></th>
<th>Current psychological wellbeing</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$R^2$</td>
<td>$\Delta R^2$</td>
<td>$\beta$</td>
<td>$p$</td>
</tr>
<tr>
<td>Model 1</td>
<td>0.04*</td>
<td>0.04*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>O*NET motivational abilities</td>
<td>0.20</td>
<td>0.02</td>
<td>0.28</td>
<td>0.001</td>
</tr>
<tr>
<td>Model 2</td>
<td>0.48***</td>
<td>0.44***</td>
<td>0.12**</td>
<td>0.04</td>
</tr>
<tr>
<td>O*NET motivational abilities</td>
<td>0.14</td>
<td>0.04</td>
<td>0.21</td>
<td>0.02</td>
</tr>
<tr>
<td>Age</td>
<td>-0.47</td>
<td>&lt;.001</td>
<td>0.04</td>
<td>0.62</td>
</tr>
<tr>
<td>Sex (1 = male, 2 = female)</td>
<td>-0.02</td>
<td>0.83</td>
<td>-0.13</td>
<td>0.16</td>
</tr>
<tr>
<td>Education (years)</td>
<td>-0.05</td>
<td>0.49</td>
<td>0.02</td>
<td>0.86</td>
</tr>
<tr>
<td>Former intelligence</td>
<td>0.40</td>
<td>&lt;.001</td>
<td>0.14</td>
<td>0.13</td>
</tr>
<tr>
<td>Model 3</td>
<td>0.51***</td>
<td>0.03</td>
<td>0.51***</td>
<td>0.40**</td>
</tr>
<tr>
<td>O*NET motivational abilities</td>
<td>0.17</td>
<td>0.02</td>
<td>0.16</td>
<td>0.03</td>
</tr>
<tr>
<td>Age</td>
<td>-0.48</td>
<td>&lt;.001</td>
<td>-0.02</td>
<td>0.72</td>
</tr>
<tr>
<td>Sex (1 = male, 2 = female)</td>
<td>0.004</td>
<td>0.96</td>
<td>-0.06</td>
<td>0.41</td>
</tr>
<tr>
<td>Education (years)</td>
<td>-0.02</td>
<td>0.81</td>
<td>0.01</td>
<td>0.93</td>
</tr>
<tr>
<td>Former intelligence</td>
<td>0.39</td>
<td>&lt;.001</td>
<td>0.05</td>
<td>0.46</td>
</tr>
<tr>
<td>O*NET cognitive abilities</td>
<td>-0.11</td>
<td>0.14</td>
<td>-0.04</td>
<td>0.63</td>
</tr>
<tr>
<td>Interaction O<em>NET motivational and O</em>NET cognitive abilities</td>
<td>-0.05</td>
<td>0.47</td>
<td>-0.03</td>
<td>0.66</td>
</tr>
<tr>
<td>Perceived Stress</td>
<td>-0.12</td>
<td>0.06</td>
<td>-0.64</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Interaction O*NET motivational abilities and perceived stress</td>
<td>0.002</td>
<td>0.98</td>
<td>-0.02</td>
<td>0.78</td>
</tr>
</tbody>
</table>

*Note.* $p < .05$. **$p < .01$. ***$p < .001$. 
Table 4

Odds Ratio of Cognitive Impairment Being Associated (Yes/No) with O*NET Motivational Abilities and other variables (N = 147)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Adjusted OR</th>
<th>95% CI</th>
<th>Wald test&lt;sup&gt;a&lt;/sup&gt;</th>
<th>p&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O*NET motivational abilities</td>
<td>0.47</td>
<td>0.26-0.85</td>
<td>6.22</td>
<td>0.01</td>
</tr>
<tr>
<td>Model 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O*NET motivational abilities</td>
<td>0.33</td>
<td>0.14-0.79</td>
<td>6.24</td>
<td>0.01</td>
</tr>
<tr>
<td>Age</td>
<td>1.25</td>
<td>1.10-1.42</td>
<td>11.04</td>
<td>0.001</td>
</tr>
<tr>
<td>Sex (1 = male, 2 = female)</td>
<td>2.25</td>
<td>0.48-10.55</td>
<td>1.06</td>
<td>0.30</td>
</tr>
<tr>
<td>Education (years)</td>
<td>1.01</td>
<td>0.69-1.49</td>
<td>0.01</td>
<td>0.94</td>
</tr>
<tr>
<td>Former intelligence</td>
<td>0.78</td>
<td>0.67-0.91</td>
<td>9.80</td>
<td>0.002</td>
</tr>
<tr>
<td>Model 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O*NET motivational abilities</td>
<td>0.24</td>
<td>0.08-0.71</td>
<td>6.60</td>
<td>0.01</td>
</tr>
<tr>
<td>Age</td>
<td>1.27</td>
<td>1.10-1.46</td>
<td>10.92</td>
<td>0.001</td>
</tr>
<tr>
<td>Sex (1 = male, 2 = female)</td>
<td>3.17</td>
<td>0.57-17.84</td>
<td>1.72</td>
<td>0.19</td>
</tr>
<tr>
<td>Education (years)</td>
<td>1.01</td>
<td>0.65-1.55</td>
<td>0.001</td>
<td>0.98</td>
</tr>
<tr>
<td>Former intelligence</td>
<td>0.77</td>
<td>0.65-0.91</td>
<td>9.54</td>
<td>0.002</td>
</tr>
<tr>
<td>O*NET cognitive abilities</td>
<td>1.93</td>
<td>0.61-6.17</td>
<td>1.24</td>
<td>0.27</td>
</tr>
<tr>
<td>Perceived Stress</td>
<td>1.09</td>
<td>0.94-1.28</td>
<td>1.28</td>
<td>0.26</td>
</tr>
</tbody>
</table>

Note. OR = odds ratio; CI = confidence interval.

<sup>a</sup>Significance of adding the respective variable to the model. <sup>b</sup>Level of significance of Wald test.
Figure Caption

Figure 1. A model of motivational reserve effects.