Distress Proneness as a Personalized Indicator of Cognitive Decline:
results from the Swedish National Study on Aging and Care (SNAC)

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Abstract

Distress proneness, as indicated by the personality trait neuroticism, has been linked with increased rates of a variety of age-related cognitive pathologies. The current study examined changes in cognitive ability over a six-year period in a 66-year-old cohort of aging individuals classified as highly distress prone. The sample population was drawn from the Swedish National study of Aging and Care database. The results of this paper indicate that distress proneness did not significantly impact cognitive decline over a six-year period in old age. Accordingly, several important distinctions should be made in order to understand why these results differ from those of previous reports concerned with similar topics.
Background

Reports stating the dire consequences of chronic stress permeate most journals of health psychology and gerontology. In particular, it is well documented that chronic stress acts cumulatively, thereby progressively facilitating the development of age-related cognitive decline and pathologies (Sotiropoulos et al., 2011). Fortunately, awareness of this trend is spurring much interest in longitudinal, gerontological research. In an effort to discover new ways of boosting cognitive longevity, studies such as the Swedish National Study for Aging and Care (SNAC) project were designed to find corresponding psychosomatic patterns within the aging populace (Qiu, 2003).

Increasing demand for studies regarding the effects of chronic stress has generated reports from diverse subfields of psychology. In response to sustained stress, biological psychologists report decreased numbers and shortening of dendrite branches among hippocampal neurons—important components for memory processing (Radley et al., 2004). Furthermore, the deleterious force of stress has been shown to be even greater in aging brains (Sapolsky, Krey, & McEwen, 1986). The combination of these findings demonstrates a great need to determine and disrupt environmental and psychological sources of stress for older adults.

A common source of stress is found in the workplace. Different lifetime principal occupations may exhibit varying levels and types of stress. This idea led researchers Qiu et al. (2003) of the Kungsholmen division of the Swedish National Study of Aging and Care (SNAC-K) to investigate the relative cognitive hazardousness of different occupations. They discovered that occupations requiring physical and manual labor--were significantly more likely to develop dementia or Alzheimer’s disease. However, a different SNAC-K study found evidence for
cognitive assistance in occupations requiring a high level of complexity (Finkel, Andel, Gatz, & Pedersen, 2009).

Pursuing the notion that occupation choice presents a particular level of risk associated with both cognitive and coronary decline, public health scientists Chandola, Heraclides, & Kumari (2010) broke down the components of workplace stressors. In addition to describing the psychophysiological reaction to work-related stress, the authors discuss models of work organization that may increase stress. Specifically, the authors drew attention to Karasek’s job strain model (1979), which states that the most stressful work conditions are those with high job demand and low job control. Following this finding, many additional research inquiries have examined and validated this model. The Karasek model was also utilized within a SNAC-K. Researchers Wang et al. (2012) discovered that when they analyzed the work history of the elderly population in Kungsholmen, those who had previous careers with sustained high-demand/low-control conditions were at greater risk for contracting Alzheimer’s disease or dementia.

Movement Toward Stress Response Personalization

The sources of stress-history are being intensely investigated, however, statements about common workplace stressors may over-generalize the effects of the stressful condition. An early exploration into the impact of stress based on individual behavior was conducted in 1993 by researchers Jorm et al. Rather than isolating a single component of life stress, such as occupational stress, Jorm and colleagues established that individuals exhibit unique reactions to stress. Specifically, those individuals demonstrating high levels of neuroticism—a specific subset of personality trait items pertaining to distress proneness—were at greater risk for dementia and cognitive decline during old age. Although this finding was disputed by a later report by Jelicic
et al., (2003), the theory of distress proneness as a predictor of cognitive decline has been validated in numerous recent studies (Wilson et al., 2006; Wilson et al., 2004; Radley, 2004).

Rather than believing change in cognitive function during old age is an inevitable developmental process, Robert S. Wilson and colleagues designed a study to argue for person-specific factors (2002). In order to determine such factors, the authors developed a longitudinal study. This study gathered individual lifestyle information and tested various forms of cognitive functioning from 694 persons aged 65 years or older on an annual basis for six years. These tests measured both global, all-around cognition as well as specific routes such as memory and perception. Overwhelmingly, the results demonstrated significant differences between individuals regarding rate and type of cognitive decline in old age. Clearly, cognitive decline as a more personalized issue merits attention.

The findings of Wilson and colleagues may appear straightforward at first glance. But, in a report on the effects of adverse experiences, Brian S. McEwen (2000) outlines the intricate physiological formation of the stress response. In his report McEwen states that human beings may become more sensitive to their own stress hormones by maintaining high stress responsiveness. In other words, an individual predisposed to distress proneness may stimulate increased sensitivity towards his or her stress hormones, thereby causing greater subsequent distress proneness. This perilous cycle is subsequently capable of causing hippocampal atrophy, begetting memory loss and, eventually, global cognitive decline. For example, an individual that is less able to habituate to the elevated levels of stress hormones, such as cortisol, induced by mandatory and frequent public speaking events, may be at greater risk for sustained hormone reactivity within the hippocampus than individuals that adapt easily. Therefore, it is possible that, in addition to being less able to habituate to psychosocial challenges, individuals scoring high on
scales of neuroticism may be less able to process stress physiologically.

In a separate case of differentiated stress response, researchers Morgan III et al, (2001) sought to discover if genetic variations existed among individuals exposed to acute cases of high-degree stress situations. Using a sample of 44 individuals participating in the US Army survival school, the authors examined the subjects before, during and after their training. Interestingly, although each participant held similar previous military training, the outcome reaffirms that individuals still exhibit significant differences in physiological threat response. Furthermore, those who generated greater and sustained physiological reactions to uncontrollable stress during the training were also significantly poorer psychologically and behaviorally in response to survival training. Indeed, examining physiological stress response before army enlistment could dramatically decrease stress-related diseases such as post-traumatic stress disorder (Morgan III et al, 2001).

Gaining momentum from a surge in research regarding the physiological correlates of the stress response mechanism, many more longitudinal research reports were produced by Robert S. Wilson and colleagues. Utilizing post-mortem brain autopsy data, clinical evaluations for dementia, and a large battery of cognitive tests at various time intervals, Wilson et al. have repeatedly found that individuals with high neuroticism scores on personality measures are two to three times more likely to develop Alzheimer’s disease or dementia and increase the rate of cognitive decline by 30% (Wilson et al., 2003; Wilson et al., 2005; Wilson et al., 2006). In an editorial statement by Breitner and Costa (2003), the authors responded to the findings of Wilson and colleagues by stating that a reproduction of these results could unravel an important new research area at the intersection of psychiatry and neurology.
Current Study

The SNAC-K Project, in part designed to assess the cognitive health of an aging population in Sweden, is a part of the Swedish National study for Aging and Care (SNAC). As a major contributing source of longitudinal data regarding cognitive longevity in Scandinavia, the SNAC data has been analyzed in numerous reports (Qiu et al., 2003; Sandin Wranker, Rennemark, M., & Berglund, J., 2011). In addition, the study is divided among four research centers located throughout Sweden, including Kungsholmen and Blekinge (SNAC-B). However, before 2001, the SNAC project was located in one area, Kungsholmen, and aptly named the Kungsholmen Project.

Regarding the impact of stress-related cognitive decline, Wang et al. (2012) utilized the Karasek model of high job-demand/low job-control to analyze a component of stress history within this aging population. However, it is clear that this type of situation-specific stress model does not satisfy the rising interest of person-specific stress models. Therefore, the suggested study of Breitner and Costa’s editorial (2003), to attempt to reproduce the findings of Wilson et al., will be investigated by the current study using data from the SNAC-B project. Specifically, the task of the current study is to attempt to discover relationships linking distress prone individuals, indicated by high scores of neuroticism in a personality scale, to more rapid cognitive decline in old age within a SNAC-B sub-sample.

Methods

Sample

The Swedish National study for Aging and Care (SNAC) is a longitudinal study aiming to identify the quality and process of aging in four national research centers within Sweden.
According to Lagergren et al. (2004), the study commenced in 2001 after meeting the ethical standards of both the Medical Faculty at Lund University and the Karolinska Institute, Stockholm, Sweden. Furthermore, the study follows a representative sample of older adults aged 60-96 years of age over time to track progress in many domains. More detailed information about the SNAC project, regarding design and layout, can be found in the outline report by Lagergren et al. (2004).

The sample data used in the current study is a sub-sample gathered from the Blekinge division of the Swedish National study of Aging and Care (SNAC-B) database. According to Sandin Wranker, Rennemark, and Berglund (2012), in 2001 the population of older adults in this municipality, known as Karlskrona, was 14,627, and contained only slightly more females (56.3%) than men. Karlskrona is located in the South-East of Sweden and maintains rural surroundings. In total, 1402 participants were collected for SNAC-B and were deemed to be representative of the Swedish aging population (Sandin Wranker, Rennemark, & Berglund, 2011).

The sub-sample data of the current study represented 206 individuals, of which 112 were women, in a ‘youngest-old’ age cohort of 66 years of age. The sample population was reexamined after a six year interval. Of the baseline 206 individuals, 14 contained missing values in their responses, leaving 192 valid responses to be included in the final analysis.

*Procedure*

According to Sandin Wranker, Rennemark, and Berglund (2011), participants entered the SNAC study on a volunteer basis. Examinations and testing were conducted by trained research staff in two parts, with each part lasting approximately 3 hours. Then a questionnaire, informed
consent, and medical record release form was distributed to and collected from each participant between the two parts.

**Measures**

It was previously reported that the personality trait, neuroticism, may also be known as distress proneness given that this is the central feature of the trait that is most often studied (Hedden & Gabrieli, 2004). At baseline, the personality of the participants was assessed using a Swedish version of the NEO-Five Factor Inventory (NEO-FFI) questionnaire (Costa & McRae, 1989). Within this test, only items 1, 6, 11, 16, 21, 26, 31, 36, 41, 46, 51, & 56 pertain specifically to the neuroticism personality trait of interest. Also, items 1, 16, 31, and 46 required reverse scoring.

To assess global cognitive functioning, participants completed a Swedish version of the Mini Mental State Exam (MMT; Lagergren, et al., 2003). This test was utilized in all reports by Wilson et al. in addition to many other papers investigating similar themes (Radley, et al., 2004; Qiu, et al., 2003; Jelicic, 2003). The MMT is composed of thirty questions examining basic cognitive ability along various domains. The current study utilizes the MMT composite score, although it is possible to utilize separate sub-domains of the results if necessary.

After a span of six years a reexamination period began and the MMT was retaken by the participants. However, previous research indicates that tests of personality remain stable beyond adolescence (Costa & McRae, 1988). Therefore, the NEO-FFI was not readministered at the six-year follow up. In other words, baseline scores of personality were reused for the six-year follow-up assessment.

**Statistical Analysis**
In order to assess the relationship between individuals demonstrating high levels of distress proneness and cognitive decline after six years a mixed-design, or ‘split-plot’, analysis of variance (ANOVA) was employed. This specific analysis was necessary because the current study examined a within-subjects design independent variable (before and after six-year aging span) in combination with a between-subjects design independent variable (high and low distress proneness). The latter variable was comprised of those individuals in the top and bottom deciles of the total neuroticism score. The decision to utilize these parameters was based on their previous use in reports by Wilson et al. (e.g., 2006). Finally, the single dependent variable, cognitive functioning, was continuous, thus satisfying all of the conditions necessary for this specific analysis. All analyses and tests of parametric assumptions were conducted via the statistical software package SPSS version 20.0 (Chicago, IL, USA). P-values of less than 0.05 were considered significant.

Results

The sample, according to neuroticism scores, was observed to follow a normal distribution and deemed satisfactory for use within parametric analysis (figure 1, p. 11). However, the threshold for meeting parametric assumptions can be interpreted with leniency due to the general robustness of the ANOVA test.
Figure 1: Histogram depicting the general distribution of total number of sub-sample participants among neuroticism scores. The chart is displaying the exact curve at which each group would need to be positioned in order to demonstrate that the distribution of scores follows a normal, bell curve. The bars in this graph match the curve of the line closely, indicating that there is a normal distribution of neuroticism throughout the sub-sample.

After viewing the data frequencies, the top decile was shown to include individuals with total neuroticism scores greater than 35. Conversely, the bottom decile included individuals with scores lower than 19. Due to participation attrition during the follow-up period, six participants with missing data values were excused from the final analysis.
(Table 1)

**Mean Score MMT by Year and Neuroticism Group**

<table>
<thead>
<tr>
<th>Neuroticism Group</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low neuroticism score</td>
<td>28.89</td>
<td>.809</td>
<td>19</td>
</tr>
<tr>
<td>MMT total test score (c. year 2001)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High neuroticism score</td>
<td>28.53</td>
<td>1.328</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>28.72</td>
<td>1.085</td>
<td>36</td>
</tr>
<tr>
<td>Low neuroticism score</td>
<td>27.47</td>
<td>3.323</td>
<td>19</td>
</tr>
<tr>
<td>MMT total test score (c. year 2007)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High neuroticism score</td>
<td>28.82</td>
<td>1.185</td>
<td>17</td>
</tr>
<tr>
<td>Total</td>
<td>28.11</td>
<td>2.605</td>
<td>36</td>
</tr>
</tbody>
</table>

Notice that the total number of individuals from low neuroticism (N = 19) and high neuroticism scores (N = 17) was 36. Furthermore, there is negligible variation among the interaction groups in terms of MMT score.

The result of the mixed-design ANOVA is displayed in the table below:

(Table 2)

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
<th>Partial Eta Squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMT Score Combined</td>
<td>5.697</td>
<td>1</td>
<td>5.697</td>
<td>1.698</td>
<td>.201</td>
<td>.048</td>
</tr>
<tr>
<td>MMT Score Combined * NscoreGROUP</td>
<td>13.197</td>
<td>1</td>
<td>13.197</td>
<td>3.933</td>
<td>.055*</td>
<td>.104</td>
</tr>
<tr>
<td>Error(MMT Score Combined)</td>
<td>114.080</td>
<td>34</td>
<td>3.355</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
It was shown that distress prone individuals were not significantly more likely to decline in cognitive function after six years, $F (1) = 3.93$, n.s. However, it should be noted that significance value ($P = .055$) approached significance. This trend can be seen more clearly when displayed visually.

(Figure 2)

![Figure 2](image-url)  

Figure 2. : In the figure above, participants demonstrating low neuroticism scores are indicated by a full line. Participants demonstrating high neuroticism scores are indicated by a dotted line. From left to right, the participants’ progress in each group was measured from baseline to re-test. Progress was measured by scores on the MMT on the vertical axis.
Graphical interpretation of the data illustrates the directional trend of the nearly-significant results. Interestingly, the trend is exactly counter to the hypothesized direction, whereby it was previously argued that low distress proneness would lead to a positive, increasing slope and high distress proneness would result in a negative, decreasing slope.

**Discussion**

The current study examined changes in cognitive ability over a six-year period in a 66-year-old cohort of aging individuals classified as distress prone. The results of this paper indicate that distress proneness did not significantly impact cognitive decline over a six-year period in old age. Moreover, a near-significant trend was achieved in a direction counter to that predicted, i.e. that distress proneness was aiding cognitive longevity. Despite these findings, there is substantial theoretical corroboration for the experimental hypothesis of the current study. Accordingly, several important distinctions should be made in order to understand why the present results differ from those of previous reports concerned with similar topics, specifically those by Wilson and colleagues (2003; 2004; 2006).

As is the case for many longitudinal studies, there is a necessity to strive for greater sample sizes in any future studies due to a high rate of attrition during follow-up periods. Unfortunately, it is uncertain whether cognitive decline impacts the tendency to drop out of longitudinal studies, thereby possibly increasing the overall scores of cognitive tests. In addition to prevalent attrition the current study contained considerably fewer participants than the model reports by Wilson et al., (2003; 2004; 2006). In addition, the current study was limited to only a single follow-up examination whereas previous papers included multiple follow-up stages. Therefore, although there was no significance reached at this stage of data collection, it is
possible that a significant trend could arise at future points of data collection. Doing so would also allow researchers to observe if paths of change are, in fact, linear and gradual or otherwise.

Wilson et al. (2002) stated among introductory comments that longitudinal studies seeking to view cognitive decline should collect data annually rather than several years apart. It was known that the SNAC database did not conform to this suggestion and this may have impacted the ability to identify micro trends of cognitive decline. However, Wilson et al. also note the possibility of participants simply getting better at taking the same cognitive tests, also known as practice effects, taking place within this design. Therefore, it is still unclear whether annual data collection is strictly necessary.

Previous studies (e.g., Chapman et al. 2011) draw from a younger to oldest-old cohort sample rather than a youngest-old sample. However, our baseline sample was restricted to participants at sixty-six years of age. Due to the emphasis placed on age as the catalyst for cognitive decline, it is possible that the sample cohort employed by the current study may not be representative of the target population.

The noticeable lack of variation among MMT results from baseline to follow-up examination. This finding was likely the result of a possible ceiling effect, whereby the sample population may have been unhampered by issues of age-related cognitive decline or the test was not sensitive to the particular level of cognitive changes taking place. In addition, cognitive decline is a heterogeneous occurrence with different people being afflicted along different domains of cognition at varying times. To combat ceiling effects, Wilson et al. (2002) argues that using an array of cognitive tests that vary in difficulty during each examination period allows for greater sensitivity towards variability in cognitive decline. For example, researchers Clark et al. (2012) report that episodic memory and executive functioning, specifically, are predictive of
cognitive decline in old age. However, the results from the Wilson et al. (2002) report indicated that cognitive decline was lowered in all domains. Nevertheless, it is recommended that future studies examine the MMT along its most pertinent axes—including memory and executive functioning—rather than global function in total.

In addition to cognitive decline, emotional decline in the form of mild or major depression may also manifest during old age. Although the insidious nature of cognitive decline remains to be completely understood, researchers have explored the impact of depression on cognitive decline (Kohler et al., 2010). The result of this research suggests that variables such as depression level should be controlled for in future studies to dismiss the possibility of a third-party effect.

Although it is well known that stress is directly linked with a host of physiological malevolence, it is the hope of the current investigation to also shed light on the cognitive costs of stress. If future studies decisively determine that distress proneness is predictive of accelerated age-related cognitive decline, then personality indicators may be an easy step towards heightened awareness of our stress sensitivity. Although personality has been shown to be remarkably stable, greater awareness may create the possibility of inventing additional measures intended to decrease distress proneness.

**Acknowledgments** I would like to thank Dr. Mikael Rennemark for his patience and assistance in accessing and understanding the SNAC database.
References


Sandin Wranker, L. W., Rennemark, M., Berglund, J., (2011), Pain among older adults with gender perspective: findings from the SNAC study. 6th World Congress at the ISPRM, 85-89. San Juan.


