HHS Public Access

Author manuscript

Aging Ment Health. Author manuscript; available in PMC 2019 May 01.

Published in final edited form as:

Aging Ment Health. 2018 May ; 22(5): 611–618. doi:10.1080/13607863.2017.1299688.

The Moderating Effects of Aging and Cognitive Abilities on the Association between Work Stress and Negative Affect

Jinshil Hyun[1], **Martin J. Sliwinski**[1], **David M. Almeida**[1], **Joshua M. Smyth**[2], and **Stacey B. Scott**[3]

[1]Department of Human Development and Family Studies and Center for Healthy Aging, Pennsylvania State University

[2]Department of Biobehavioral Health, Pennsylvania State University

[3]Department of Psychology, Stony Brook University

Abstract

Objectives—Given that the association between work stress and negative affect can exacerbate negative health and workplace outcomes, it is important to identify the protective and risk factors that moderate this association. Socioemotional aging and cognitive abilities might influence how people utilize emotion regulation skills and engage in practical problem solving to manage their work stress. The aim of this study is to examine whether age and cognitive abilities independently and interactively moderate the association between work-related stress and negative affect.

Method—A diverse working adult sample (*N*=139, age 25–65, 69% of females) completed a cross-sectional survey that assessed chronic work stress, negative affect, and fluid and crystallized cognitive abilities.

Results—Results from regression analyses suggested that both fluid and crystallized cognitive abilities, but not age, moderated the association between work stress and negative affect. Further, we found that crystallized cognition had a stronger attenuating effect on the work stress—negative affect association for older compared to younger workers. The moderating effect of fluid cognition was invariant across age.

Conclusion—Our findings demonstrate that cognitive abilities are an important personal resource that might protect individuals against the negative impacts of work stress and negative affect. Although the role that fluid cognition plays in work stress—negative affect association is comparably important for both younger and older workers, crystallized cognition might play a more valuable role for older than younger workers.

Keywords

fluid cognition; crystallized cognition; work stress; negative affect; older workers

Address correspondence regarding this manuscript to: Martin Sliwinski, The Center for Healthy Aging, The Pennsylvania State University, 402, Biobehavioral Health Building, University Park, PA 16802, USA, mjs56@psu.edu.

Introduction

Prolonged occupational stress can negatively impact workers' mood, resulting in deteriorated mental and physical health, work motivation, and workplace performance (Motowidlo, Packard, & Manning, 1986; Stansfeld & Candy, 2006; Wilhelm, Kovess, Rios-Seidel, & Finch, 2004). Conversely, negative mood can exacerbate the effects of chronic stress on health consequences (Cohen, Kessler, & Gordon, 1997) as well as work outcomes (Cropanzano, James, & Konovsky, 1993). Given the association between work stress and negative affect (NA) and its implications for health and work-related outcomes, it is important to examine the protective and risk factors that moderate this relationship. Moreover, as adults are working into older ages than ever before (Kulik, Ryan, Harper, & George, 2014; Toossi, 2012), identifying risk and protective factors is especially important for protecting older workers' health and promoting workplace productivity in an older workforce. Most studies that have investigated the protective factors against the work stress, however, have focused on personal resources conveyed by demographic and psychosocial factors such as gender, self-esteem, sense of control, and social support (Folkman, 1984; Lazarus & Folkman, 1984; Martocchio & O'Leary, 1989; Torkelson & Muhonen, 2004; Viswesvaran, Sanchez, & Fisher, 1999), without addressing whether those associations differ between older and younger workers. This is problematic because available resources (e.g., increase in expertise) or limitations (e.g., decrease in cognitive or physical function) for older workers to deal with workplace stress might be different from younger workers. Little is known, however, about whether aging and age-related changes in personal resources attenuate or enhance the association between work-related stress and NA (e.g., Kanfer & Ackerman, 2004).

In the workplace context, cognitive abilities may be a particularly important personal resource to manage work stress by supporting practical problem solving and utilization of socioemotional cues for social inference that may be accumulated in social and cultural system (Hess, Osowski, & Leclerc, 2005). Because some cognitive functioning starts to exhibit age-related changes in one's 20s or 30s (Horn & Cattell, 1967; Nisbett et al., 2012; Salthouse, 2009), understanding the role that cognitive abilities play in moderating the association between work stress and NA across adulthood is of theoretical as well as practical interest. The overall aim of the current study is to examine whether and to what extent aging and cognitive abilities independently and interactively moderate the association between work stress and NA.

Theories of emotional aging, such as Socioemotional Selectivity Theory (SST; Carstensen, Isaacowitz, & Charles, 1999) and the Strength and Vulnerability Integration (SAVI) theory (Charles, 2010), both posit that age-related changes in motivation and coping skills allow older adults to experience preserved and perhaps enhanced affective well-being (e.g., low levels of negative emotion) compared to younger adults. Specifically, there seems to be a consistent pattern of an age-related decrease in NA from young adulthood until the mid-60s (Charles, 2010; Charles, Reynolds, & Gatz, 2001; Mroczek & Kolarz, 1998). SST postulates that this decrease in NA results from a shift in future time perspective as aging adults' perception of time left to live grows shorter. The narrowing of future time perspective encourages prioritization of emotionally meaningful goals, rather than goals related to information and knowledge acquisition, which presumably increases motivation to regulate emotions, minimize stress, and maintain high levels of affective well-being among older adults (Carstensen, Isaacowitz, & Charles, 1999). Moreover, aging affords the opportunity for individuals to accumulate knowledge on the usage of cognitive and behavioral skills to regulate emotions (Charles, 2010), which may enable older workers to more effectively manage the negative effects of stress at work than their younger counterparts. This leads to our first hypothesis, that the relation between higher levels of work stress and higher levels of NA will be weaker in older compared to younger workers.

There may, however, be individual differences in cognitive resources that influence whether people, regardless of their age, are able to effectively leverage their emotion regulation and coping skills to deal with stress (Rickenbach, Condeelis, & Haley, 2015; Stawski, Almeida, Lachman, Tun, & Rosnick, 2010; Stawski, Mogle, & Sliwinski, 2013). To explore this issue, we drew upon Horn's distinction between fluid and crystallized abilities (Horn, 1968). Fluid cognitive abilities (Gf) indicates the ability to reason and solve novel problems (independent of past knowledge), and crystallized cognitive abilities (Gc) refer to the capacity of individuals to use learned knowledge and experience (Blair, 2006; Cattell, 1963; Horn & Cattell, 1966; Nisbett et al., 2012). Both types of cognitive abilities may moderate the relation between work stress and NA in different ways. First, high levels of Gf may reflect an individual's ability to cope with, adapt to, and resolve novel or unexpected stressful situations. Second, high levels of Gc may reflect an individual's capacity to cope with and resolve stressful situations that are amenable to pragmatic solutions that depend upon previously acquired repertoires of knowledge and skills (Blair, 2006; Sternberg, 1985).

Only a few empirical studies, however, have examined the role of cognitive abilities in moderating the association between stress and affect. Rickenbach and colleagues (2015) examined whether the daily association between general life stress and NA shows different pattern in terms of cognitive status among older adults. They found that days with greater numbers and severity of stressors were associated with enhanced NA only for people with mild cognitive impairment. For cognitively healthy older adults, however, there was no significant association between daily stress and NA, suggesting that cognitive ability might act as a protective factor for older adults in dealing with daily stress. A few other studies have examined whether individual differences in cognitive abilities moderate the association between daily stress and NA. Stawski and colleagues (Stawski et al., 2010, 2013) used daily diary methods to examine how cognitive abilities moderate the association between affect and different types of stressors such as interpersonal, network, and work- or home-overload stressors. They found significant moderating effects of Gf for interpersonal and network stressors (Stawski et al., 2010, 2013), but not for work-related stress (Stawski et al., 2010). Because Gf did not moderate the association between daily work stress and NA, Stawski and colleagues suggested that work stress, which may be more repetitive and predictable than other types of stress, might benefit more from Gc than Gf. The role that crystallized cognition might play in the association between work-related stress and affect, however, has not yet been examined. Given the potential importance of accumulated experiences and knowledge in dealing with work stress, the next step is to examine whether crystallized cognition, as well as fluid cognition, moderates the association between work stress and affect. Thus, our second hypothesis is that the relation between works stress and NA should be weaker among people with higher fluid and/or crystallized cognitive abilities.

Fluid and crystallized cognitive abilities, however, show different patterns of age-related changes across adulthood (Park, 2000; Salthouse, 2004; Schaie, 2012). Fluid cognitive abilities reach their maximum in early adulthood (i.e., early 20s) and show normative age-related decline thereafter. On the other hand, crystallized cognitive abilities are stable or increasing until at least age 60 (Blair, 2006, 2010; Cattell, 1963; Horn & Cattell, 1966, 1967; Nisbett et al., 2012; Salthouse, 2009). If cognitive abilities moderate the association between work stress and NA, age-related differences in these abilities might be a potential vulnerability that could compromise the coping skills to deal with work stress (Charles & Luong, 2013; Kanfer & Ackerman, 2004; Park, 1994). This line of reasoning leads to our third hypothesis, that individual differences in cognitive abilities will be a more important moderator of the work stress—NA relation for older than younger workers.

To summarize, the goal of our current study is to examine the moderating effects of age and cognitive abilities as well as the interactive effects between age and cognition on the association between work stress and NA by testing three hypotheses. First, following SAVI, we predict that older workers will exhibit a weaker association between work stress and NA than younger workers (Hypothesis 1). Second, we predict that individuals with higher levels of fluid and crystallized cognitive function will exhibit attenuated associations between work stress and NA (Hypothesis 2). Because well-studied resilience factors such as self-esteem, sense of control, and emotional support are known to buffer against the effects of stress, we also examined whether the moderating effect of cognitive function was independent of these variables. Third, we predict that individual differences in cognitive function will be a more important moderator of the work stress—NA relationship for older compared to younger workers (Hypothesis 3).

Methods

Participants

Participants (N=304) were recruited using systematic probability sampling of New York City Registered Voter Lists for the zip code 10475 (Bronx, NY). The data were collected as part of a longitudinal study "The Effects of Stress on Cognitive Aging, Physiology and Emotion" (ESCAPE) (see Scott et al., 2015), but only data from the first wave were analyzed for this manuscript. Out of the original sample, data from those who were in working status at the time of survey were selected for this study (N=155). Data of 16 participants were omitted because they were missing either the IQ or work stress score. As a result, data for 139 adults (69% women) were used. The mean age of the sub-sample was 45.6 (SD=10.17, range 25–65) and there was no significant difference in average age between males (mean age=45.09, SD=10.46, range=28–63) and females (mean age=45.85, SD=10.08, range=25–65). The entire sample (N=304) was representative of the Bronx, NY area from which it was sampled, and the subsample of working adults used for this analysis had similar distribution as original sample in sex, ethnicity, and marital status. As would be expected, the subsample of working adults was significantly younger (t(286)=2.49, p=.01), had higher education levels (p=.002; Fisher's Exact Test), and had higher income levels (p=.

000; Fisher's Exact Test) than the subsample of nonworking adults. Descriptive data for working and nonworking adults, as well as the younger and older portions among working adults, are provided in Table 1.

Procedure

The Albert Einstein College of Medicine of Yeshiva University ethical review board approved the study protocol. During recruitment, introductory letters were mailed to individuals from a sampling frame (obtained from the Registered Voter Lists) and a research assistant phoned to establish eligibility, and enroll and consent interested persons. Eligible participants are 25 to 65 years of age, ambulatory, fluent in English, without visual impairment, and a resident of Bronx County. Participants were mailed paper survey batteries assessing demographic and psychosocial characteristics that they completed at home and brought to their lab visit. During the lab visit, participants completed a battery of cognitive tests including two tests to measure fluid and crystallized cognition. Participants who completed survey measures and in-lab cognitive tests could receive up to $50 and those who completed the entire study protocol could receive up to $160. The ESCAPE project also included an experience sampling protocol using smartphones; thus participants were excluded if they were unable to complete this portion of the project. The detailed procedure for the entire study is published elsewhere (Scott et al., 2015).

Measures

Work Stress—The eight items from the work stress subscale of the Wheaton Chronic Stress Inventory were used to index work stress (Wheaton, 1994, 1996). Participants were asked to rate the extent to which items (Wheaton, 1994) such as "You have more work to do than most people" and "You want to achieve more at work, but things get in the way" described their life on a scale ranging from 1 (not at all true) to 3 (very true). Cronbach's alpha for the eight items was .70. A composite work stress variable was constructed that reflected the average of the eight items and was *z*-standardized (mean=0, SD=1).

Negative Affect (NA)—Participants were asked to report the level of their negative emotion in the last month from 1 (not at all) to 7 (extremely) scale. Ten items were selected to represent negative affect (NA) including irritable, tense, bored, stressed, depressed, nervous, sad, sluggish, upset, and disappointed. Cronbach's alpha for the ten items was .91, and the composite variable of ten items was used as an outcome variable to indicate NA.

Fluid cognition (Gf)—Gf was assessed by the Ravens Progressive Matrices, which is a nonverbal test of reasoning ability (Raven, 2000). Participants were asked to choose one of the picture choices at the bottom that best fitted in the missing piece of the picture at the top. Participants had twenty minutes to work through 30 items. We used only the 30 odd items, so that other 30 items can be used in the next wave of the longitudinal study. The reliability of the thirty items was .86 and total number of correct response was counted and transformed into standardized *z* score.

Crystallized cognition (Gc)—Gc was assessed by a revision of the Shipley vocabulary test (Zachary & Shipley, 1986). Participants were shown one capitalized letter along with four other words, and then asked to pick a word that means the same thing with the capitalized one (e.g., EVIDENT/green, obvious, skeptical, afraid). Each participant worked through 40 items. The reliability of the forty items was .80 and total number of correct response was counted and transformed into standardized *z* score.

Age, sex, education level, and health limitations—Age was centered at the sample mean (45). Sex was contrast coded as a male or a female. Education level was coded as one of three categories including low (completed grade school or less, some high school), middle (completed high school or received GED, some college), and high (completed college, and graduate or professional degree). Health limitations were measured using ten items which described physical limitations and difficulties (e.g., “Does your health now limit you in doing vigorous activities such as running, lifting heavy objects, participating in strenuous sports?”) from PROMIS scale (PROMIS Health Organization, 2012). The reliability of the ten items was .90 and a composite variable of the ten items was centered at the sample mean.

Self-esteem, sense of control, and emotional support—Self-esteem was measured using the 10-item Rosenberg Self-Esteem scale (Rosenberg, 1965). Participants were asked to rate each item that describes their general feelings about themselves from 0 (strongly disagree) to 3 (strongly agree) scale. Cronbach’s alpha for the ten items was .85. Sense of control was measured using twelve items that indicated personal mastery or perceived constraints (Lachman & Weaver, 1998b, 1998a). Participants were asked to rate each item from 1 (strongly disagree) to 7 (strongly agree) scale. Cronbach’s alpha for the ten items was .86. Participants were asked to rate six items related to emotional support from 1 (never) to 5 (always) scale (PROMIS Health Organization, 2012). Cronbach’s alpha for the ten items was .96. Z-score composite variables for self-esteem, sense of control, and emotional support, were used in the analyses.

Results

Table 2 shows descriptive statistics and correlations among study variables. Work stress was positively correlated with NA ($r = .44$, $p < .01$) and was negatively correlated with age ($r = -.17$, $p < .05$). Work stress was not significantly correlated with either Gf or Gc. Consistent with prior work on intelligence and aging, age had a significant negative relation with Gf ($r = -.25$, $p < .01$), but no significant association with Gc ($r = .07$, *ns*). Gf and Gc correlated with each other ($r = .52$, $p < .01$). In Table 3, the mean scores in key variables were compared between younger (age 25–45) versus older (age 46–65) workers. A median split (median age=45) was used to identify younger versus older group, although following hypothesis testing used age as a continuous variable. Table 3 shows that works stress, NA, and Gf were significantly higher in younger compared to older workers, but that there was no age difference in Gc.

Preliminary analyses indicated that the relation between work stress and NA was linear and that there was no evidence for a quadratic effect of work stress ($\beta = .07$, $p = .39$), thus subsequent models did not include quadratic term of work stress. Results from regression analyses that examined the effects of all covariates on NA suggested that sex and education were not significantly related to NA, although age ($\beta = -.18$, $p < .05$) and health limitations ($\beta = .29$, $p < .001$) were significantly associated with NA.

We evaluated Hypothesis 1, which predicts that older workers would exhibit a weaker association between work stress and NA than younger workers, by testing the interaction between age and work stress. Results from regression analysis failed to confirm this hypothesis (Table 4, Age Model). There was a significant positive association between work stress and NA ($\beta = .40$, $p < .001$) but this association was not moderated by age ($\beta = .04$, $p = .58$).

Hypothesis 2 states that individuals with higher levels of fluid and crystallized cognitive function will exhibit attenuated associations between work stress and NA. We tested this prediction in two separate models that examined the moderating effects of fluid (Table 4, Gf Model) and crystallized cognitive abilities (Table 4, Gc Model). Results from the Gf Model indicated that, as predicted, the association between work stress and NA was weaker for individuals with higher compared to lower Gf ($\beta = -0.25$, $p = .001$). Results from the Gc Model revealed a similar result, such that the association between work stress and NA was weaker among people with higher levels of Gc ($\beta = -0.17$, $p < .05$). Figure 1 illustrates these moderating effects of Gf and Gc, respectively.

We conducted two supplemental analyses to bolster these findings as well as to provide information on the magnitude and range of the moderating effects of Gf and Gc. First, the Johnson-Neyman technique was used to identify the range of values of cognitive abilities for which the association between work stress and NA is statistically significant ($p < .05$) (Johnson & Neyman, 1936; Preacher, Curran, & Bauer, 2006). Results showed that the associations between work stress and NA were significant when participants scored below .76 on Gf and below 1.03 on Gc. Because Gf and Gc were standardized z scores with the means of 0 and the SDs of 1, these results suggested that work stress had significantly negative associations with NA for most people in this sample (72% of a sample for Gf; 86% for Gc). And second, to examine whether the moderating effect of cognitive function was independent of the well-studied resilience factors, we included the moderating effects of self-esteem, sense of control, and emotional support, respectively in the above Gf and Gc Models. Results indicated that the interactions between cognitive abilities and work stress remained significant (Gf Model: $\beta = -.30$, $p < .001$; Gc Model: $\beta = -.18$, $p = .02$) after controlling for those factors. Among those resilience factors, only emotional support significantly interacted with work stress (Gf Model: $\beta = -.19$, $p < .01$; Gc Model: $\beta = -.19$, $p = .01$).

Next, we evaluated Hypothesis 3, which predicts that individual differences in cognitive function would be a more important moderator of the work stress—NA relationship for older compared to younger workers, by testing the 3-way interactions among work stress, age, and cognitive abilities. Two separate models were used to examine whether the Gf × work stress (Table 5, Gf-Age Model) and Gc × work stress interactions (Table 5, Gc-Age Model) varied across age. The three-way interaction among Gf, age, and work stress was not significant (Gf-Age Model: $\beta = 0.00$, *ns*), indicating that the moderating effect of fluid cognition was invariant across age. In the Gc-Age Model, however, the three-way Gc × age × work stress interaction was significant ($\beta = -0.27$, $p < .01$), indicating that Gc had a stronger attenuating effect on the work stress—NA relationship for older compared to younger workers.

Discussion

The current findings provide evidence that fluid and crystallized cognitive abilities are important moderators that attenuate the association between work stress and NA. Because both NA and work stress can independently influence work motivation, productivity and health (Motowidlo, Packard, & Manning, 1986; Stansfeld & Candy, 2006; Wilhelm, Kovess, Rios-Seidel, & Finch, 2004), understanding factors that moderate the work stress—NA association may have important implications for health and work related outcomes. However, due to the limitations of cross-sectional design of the current study, we cannot determine whether NA precedes or results from work stress. There was a significant interactive effect among age, Gc, and work stress on NA, implying that Gc might be a more important protective factor against work stress and NA among older than younger workers. The effect of having high levels of Gf appeared invariant across adulthood, implying that fluid cognition might be equally beneficial to both younger and older workers.

Older adults often display lower levels of negative emotions than younger adults (Charles, 2010; Charles, Reynolds, & Gatz, 2001; Mroczek & Kolarz, 1998). Theories of emotional aging suggest that this may be due to the prioritization of emotional goals and accumulation of knowledge and skills that permit successful emotion regulation among older compared to younger adults (Carstensen et al., 1999; Chalres, 2010). An important way that older adults regulate their emotions is by avoiding and removing themselves from potentially stressful and negative situations and decreasing the size of their social network (Charles, 2010). The workplace, however, might be a context in which performance-related goals are prioritized over emotional-focused goals across all age groups. Moreover, work-related challenges may not be amenable to regulation strategies in older adults which rely on avoidance and social selection. Thus, typical age advantages may not manifest in the context of work-related challenges and older workers' affective well-being may be no better than younger workers' affect. This line of reasoning described the current finding that age did not moderate the relation between work stress and NA.

As predicted, both fluid and crystallized cognitive abilities moderated the association between work stress and NA, and these moderating effects of Gf/Gc were above and beyond the effects of other well-known psychosocial factors. The results extend work by Stawski and colleagues (2010; 2013), which only examined the moderating role of fluid cognition for work stress, by showing that crystallized cognition moderated the relation between work stress and NA. However, our findings are not entirely consistent with Stawski and colleagues (2010), who did not observe evidence of a moderating effect of Gf on the daily work stress—NA relationship. The use of different measures of Gf may account for this discrepancy; in Stawski and colleagues (2010), Gf was measured in a telephone interview with the Brief Test of Adult Cognition by Telephone (Tun & Lachman, 2006) that used a composite of verbal tests of memory, fluency, inductive reasoning and processing speed. The present study assessed Gf using the non-verbal Ravens Progressive Matrices (Raven, 2000), which is known to be a good indicator to measure fluid cognition, the capacity to reason and solve a novel problem (Conway, Cowan, Bunting, Therriault, & Minkoff, 2002). How each study operationalized and measured stress also differed; Stawski and colleagues (2010) measured acute daily stressors that came from discrete events, whereas our study assessed chronic, ongoing work stress measured by global assessments related to individuals' perceptions of work roles. Moreover, a cross-sectional design of our study might assess experiences of stress and NA differently from work by Stawski and colleagues (2010; 2013) that used a daily diary study design; future research will need to examine whether the reports of experiencing NA and stressful events change in different temporal frames (e.g., assessments that measure chronic vs. daily vs. momentary experiences).

In partial support of hypothesis 3, we found that Gc (but not Gf) was a more important moderator on the association between work stress and NA among older compared to younger workers. The workplace might be a specific form of a social context that requires individuals to accumulate skills and internalize cultural and organizational rules and systems. People who score high on tests of Gc might be better able to manage work-related stress by drawing on practical strategies to solve problems or utilize socioemotional cues in the organizational system (Hess et al., 2005; Kanfer & Ackerman, 2004). The SAVI framework (Charles, 2010) also suggests that accumulated knowledge may help older individuals utilize behavioral or coping skills to deal with the negative effects of work stress and enhance their affective well-being relative to younger adults, which is in line with this result. Thus, having higher Gc may "play to the strengths" of older workers in their efforts to cope with work stress and regulate negative emotions.

The non-significant three way Gf × age × work stress interaction indicates that the moderating effect of Gf was invariant across age. That is, Gf seems to be an important moderator for both younger and older workers that attenuates the association between work stress and NA. Although a substantial part of intelligence is genetically determined (heritability between .4 and .8; Nisbett et al., 2012), cognitive abilities are also shaped through education, training, and environmental factors (Brinch & Galloway, 2012; Jaeggi, Buschkuehl, Jonides, & Perrig, 2008; Neisser et al., 1996; Nisbett et al., 2012). Some recent findings suggest that working memory or executive functioning training can improve Gf (Basak, Boot, Voss, & Kramer, 2008; Borella, Carretti, Riboldi, & De Beni, 2010; Karbach & Kray, 2009), with some evidence that this effect may be persistent (Borella et al., 2010). For example, verbal working memory training for three 1-hour sessions had transfer effects on Gf as well as specific training gains at the criterion task compared to control participants, and the effects lasted for eight months (Borella et al., 2010). Because Gf decreases with age, interventions that enhance Gf might prove especially beneficial to older workers by providing them the cognitive abilities to buffer against the effects of work stress and NA.

Limitations and Future Directions

This study has several limitations that should be considered for future research. First, due to the cross-sectional nature of this study, we cannot establish directionality among variables (e.g., work stress may impact cognitive function; Andel, Crowe, Kareholt, Wastesson, & Parker, 2011). Second, future work will need to distinguish individual differences in personal cognitive resources from intelligence-related environmental benefits (e.g., job control, social prestige, workplace culture) that may influence NA and work-stress management by measuring the types of job or job characteristics (Ettner & Grzywacz, 2001). Future work would also benefit from assessing contextual factors such as work hours or physical demands that might influence work stress. Third, better assessment of occupational features and job demands would help determine whether Gc benefited older workers more than younger workers because of aging-related differences or differences in work roles they occupy. Fourth, how we assessed fluid and crystallized cognition might limit the generalizability of the present results. For example, Gc measured by Shipley vocabulary test may not accurately reflect the amount of stored knowledge from work experiences. Additional measures that can directly assess domain knowledge from work experiences would be useful to examine whether knowledge that older workers accumulated through work experiences assists them in coping with the effects of work-related stress. And finally, this study did not examine the temporal sequencing of the relationship between work stress and NA within individuals. Use of micro-longitudinal designs, such as ecological momentary assessment (Shiffman, Stone, & Hufford, 2008), would permit analysis that sequenced the occurrence of work-related stressors and emotional responses, and how cognitive abilities and aging may moderate this relationship in real-time.

Despite these limitations, the present results provide evidence that fluid and crystallized cognitive abilities might be important protective factors, among older as well as younger workers, against the negative effects of work stress and NA. These findings also prompt consideration of alternative approaches for assessing the impact of intervention to prevent cognitive decline in aging adults. For example, interventions designed to enhance fluid cognition among older adults, in addition to improving cognitive outcomes (e.g., Basak et al., 2008; Borella et al., 2010), may also improve health and well-being by enhancing the ability of older adults to cope with stressful situations in cognitively demanding contexts (e.g., the workplace). This possibility is interesting because more adults are working into older ages, and programs which could enhance cognitive and emotional resources might positively influence work motivation, workplace productivity as well as physical and mental health among older workers.

Acknowledgments

This research was supported by National Institute of Health (NIH) grants R01 AG039409, R01 AG042595, P01 AG03949, National Institute on Aging (NIA) grant T32 AG049676 to the Pennsylvania State University, CTSA 1UL1TR001073 from the National Center for Advancing Translational Sciences (NCATS), the Leonard and Sylvia Marx Foundation, and the Czap Foundation. We also would like to thank Robert S. Stawski at Oregon State University for his useful comments and support.

References

Andel R, Crowe M, Kareholt I, Wastesson J, Parker MG. Indicators of job strain at midlife and cognitive functioning in advanced old age. The Journals of Gerontology Series B: Psychological Sciences and Social Sciences. 2011; 66B(3):287–291. https://doi.org/10.1093/geronb/gbq105.

Basak C, Boot WR, Voss MW, Kramer AF. Can training in a real-time strategy video game attenuate cognitive decline in older adults? Psychology and Aging. 2008; 23(4):765–777. https://doi.org/10.1037/a0013494. [PubMed: 19140648]

Blair C. How similar are fluid cognition and general intelligence? A developmental neuroscience perspective on fluid cognition as an aspect of human cognitive ability. The Behavioral and Brain

Sciences. 2006; 29(2):109-125-160. https://doi.org/10.1017/S0140525X06009034. [PubMed: 16606477]

Blair, C. The handbook of life-span development. John Wiley & Sons, Inc; 2010. Fluid cognitive abilities and general intelligence.

Borella E, Carretti B, Riboldi F, De Beni R. Working memory training in older adults: Evidence of transfer and maintenance effects. Psychology and Aging. 2010; 25(4):767–778. https://doi.org/10.1037/a0020683. [PubMed: 20973604]

Brinch CN, Galloway TA. Schooling in adolescence raises IQ scores. Proceedings of the National Academy of Sciences. 2012; 109(2):425–430.

Carstensen LL, Isaacowitz DM, Charles ST. Taking time seriously: A theory of socioemotional selectivity. American Psychologist. 1999; 54(3):165. [PubMed: 10199217]

Cattell RB. Theory of fluid and crystallized intelligence: a critical experiment. Journal of Educational Psychology. 1963; 54(1)

Charles ST. Strength and vulnerability integration: a model of emotional well-being across adulthood. Psychological Bulletin. 2010; 136(6):1068. [PubMed: 21038939]

Charles ST, Luong G. Emotional experience across adulthood the theoretical model of strength and vulnerability integration. Current Directions in Psychological Science. 2013; 22(6):443–448.

Charles ST, Reynolds CA, Gatz M. Age-related differences and change in positive and negative affect over 23 years. Journal of Personality and Social Psychology. 2001; 80(1):136–151. https://doi.org/10.1037/0022-3514.80.1.136. [PubMed: 11195886]

Cohen, S., Kessler, RC., Gordon, LU. Measuring stress: A guide for health and social scientists. Oxford University Press; 1997.

Conway ARA, Cowan N, Bunting MF, Therriault DJ, Minkoff SRB. A latent variable analysis of working memory capacity, short-term memory capacity, processing speed, and general fluid intelligence. Intelligence. 2002; 30(2):163–183. https://doi.org/10.1016/S0160-2896(01)00096-4.

Cropanzano R, James K, Konovsky MA. Dispositional affectivity as a predictor of work attitudes and job performance. Journal of Organizational Behavior. 1993; 14(6):595–606.

Ettner SL, Grzywacz JG. Workers' perceptions of how jobs affect health: A social ecological perspective. Journal of Occupational Health Psychology. 2001; 6(2):101–113. https://doi.org/10.1037/1076-8998.6.2.101. [PubMed: 11326723]

Folkman S. Personal control and stress and coping processes: A theoretical analysis. Journal of Personality and Social Psychology. 1984; 46(4):839–852. https://doi.org/10.1037/0022-3514.46.4.839. [PubMed: 6737195]

Hess TM, Osowski NL, Leclerc CM. Age and experience influences on the complexity of social inferences. Psychology and Aging. 2005; 20(3):447. [PubMed: 16248704]

Horn JL. Organization of abilities and the development of intelligence. Psychological Review. 1968; 75(3):242. [PubMed: 4875815]

Horn JL, Cattell RB. Refinement and test of the theory of fluid and crystallized general intelligences. Journal of Educational Psychology. 1966; 57(5):253–270. https://doi.org/10.1037/h0023816. [PubMed: 5918295]

Horn JL, Cattell RB. Age differences in fluid and crystallized intelligence. Acta Psychologica. 1967; 26:107–129. https://doi.org/10.1016/0001-6918(67)90011-X. [PubMed: 6037305]

Jaeggi SM, Buschkuehl M, Jonides J, Perrig WJ. Improving fluid intelligence with training on working memory. Proceedings of the National Academy of Sciences. 2008; 105(19):6829–6833. https://doi.org/10.1073/pnas.0801268105.

Johnson PO, Neyman J. Tests of certain linear hypotheses and their application to some educational problems. Statistical Research Memoirs. 1936; 1:57–93.

Kanfer R, Ackerman PL. Aging, adult development, and work motivation. Academy of Management Review. 2004; 29(3):440–458. https://doi.org/10.5465/AMR.2004.13670969.

Karbach J, Kray J. How useful is executive control training? Age differences in near and far transfer of task-switching training. Developmental Science. 2009; 12(6):978–990. https://doi.org/10.1111/j.1467-7687.2009.00846.x. [PubMed: 19840052]

Kulik CT, Ryan S, Harper S, George G. Aging populations and management. Academy of Management Journal. 2014; 57(4):929–935. https://doi.org/10.5465/amj.2014.4004.

Lachman ME, Weaver SL. Sociodemographic variations in the sense of control by domain: Findings from the MacArthur studies of midlife. Psychology and Aging. 1998a; 13(4):553–562. https://doi.org/10.1037/0882-7974.13.4.553. [PubMed: 9883456]

Lachman ME, Weaver SL. The sense of control as a moderator of social class differences in health and well-being. Journal of Personality and Social Psychology. 1998b; 74(3):763–773. https://doi.org/10.1037/0022-3514.74.3.763. [PubMed: 9523418]

Lazarus, RS., Folkman, S. Stress, appraisal, and coping. New York: Springer Pub. Co; 1984.

Martocchio JJ, O'Leary AM. Sex differences in occupational stress: A meta-analytic review. Journal of Applied Psychology. 1989; 74(3):495–501. https://doi.org/10.1037/0021-9010.74.3.495. [PubMed: 2737994]

Motowidlo SJ, Packard JS, Manning MR. Occupational stress: its causes and consequences for job performance. Journal of Applied Psychology. 1986; 71(4):618. [PubMed: 3804934]

Mroczek DK, Kolarz CM. The effect of age on positive and negative affect: a developmental perspective on happiness. Journal of Personality and Social Psychology. 1998; 75(5):1333. [PubMed: 9866191]

Neisser U, Boodoo G, Bouchard TJ Jr, Boykin AW, Brody N, … Ceci SJ, et al. Intelligence: knowns and unknowns. American Psychologist. 1996; 51(2):77.

Nisbett RE, Aronson J, Blair C, Dickens W, Flynn J, Halpern DF, Turkheimer E. Intelligence: New findings and theoretical developments. American Psychologist. 2012; 67(2):130–159. https://doi.org/10.1037/a0026699. [PubMed: 22233090]

Park DC. Aging, cognition, and work. Human Performance. 1994; 7(3):181–205. https://doi.org/10.1080/08959289409539854.

Park, DC. Cognitive aging: A primer. Psychology Press; 2000.

Preacher KJ, Curran PJ, Bauer DJ. Computational tools for probing interactions in multiple linear regression, multilevel modeling, and latent curve analysis. Journal of Educational and Behavioral Statistics. 2006; 31(4):437–448. https://doi.org/10.3102/10769986031004437.

PROMIS Health Organization. Physical function-short form 10a. 2012. Unpublished instrument. Retrieved from https://www.assessmentcenter.net

Raven J. The raven's progressive matrices: Change and stability over culture and time. Cognitive Psychology. 2000; 41(1):1–48. https://doi.org/10.1006/cogp.1999.0735. [PubMed: 10945921]

Rickenbach EH, Condeelis KL, Haley WE. Daily stressors and emotional reactivity in individuals with mild cognitive impairment and cognitively healthy controls. Psychology and Aging. 2015; 30(2): 420–431. https://doi.org/10.1037/a0038973. [PubMed: 25938249]

Salthouse TA. What and when of cognitive aging. Current Directions in Psychological Science. 2004; 13(4):140–144.

Salthouse TA. When does age-related cognitive decline begin? Neurobiology of Aging. 2009; 30(4): 507–514. [PubMed: 19231028]

Schaie, KW. Developmental influences on adult intelligence: The Seattle longitudinal study. Oxford University Press; 2012.

Scott SB, Graham-Engeland JE, Engeland CG, Smyth JM, Almeida DM, Katz MJ, … Sliwinski MJ. The effects of stress on cognitive aging, physiology and emotion (ESCAPE) project. BMC Psychiatry. 2015; 15(1) https://doi.org/10.1186/s12888-015-0497-7.

Shiffman S, Stone AA, Hufford MR. Ecological momentary assessment. Annual Review of Clinical Psychology. 2008; 4(1):1–32. https://doi.org/10.1146/annurev.clinpsy.3.022806.091415.

Stansfeld S, Candy B. Psychosocial work environment and mental health—a meta-analytic review. Scandinavian Journal of Work, Environment & Health. 2006; 32(6):443–462.

Stawski RS, Almeida DM, Lachman ME, Tun PA, Rosnick CB. Fluid cognitive ability is associated with greater exposure and smaller reactions to daily stressors. Psychology and Aging. 2010; 25:330–342. https://doi.org/10.1037/a0018246. [PubMed: 20545418]

Stawski RS, Mogle JA, Sliwinski MJ. Associations among fluid and crystallized cognition and daily stress processes in older adults. Psychology and Aging. 2013; 28(1):57–63. https://doi.org/10.1037/a0029813. [PubMed: 22946522]

Sternberg, RJ. Beyond IQ: A triarchic theory of human intelligence. CUP Archive; 1985.

Toossi M. Labor force projections to 2020: A more slowly growing workforce. Monthly Labor Review. 2012; 135:43.

Torkelson E, Muhonen T. The role of gender and job level in coping with occupational stress. Work & Stress. 2004; 18(3):267–274. https://doi.org/10.1080/02678370412331323915.

Tun PA, Lachman ME. Telephone assessment of cognitive function in adulthood: the Brief Test of Adult Cognition by Telephone. Age and Ageing. 2006; 35(6):629–632. https://doi.org/10.1093/ageing/afl095. [PubMed: 16943264]

Viswesvaran C, Sanchez JI, Fisher J. The role of social support in the process of work stress: A meta-analysis. Journal of Vocational Behavior. 1999; 54(2):314–334. https://doi.org/10.1006/jvbe.1998.1661.

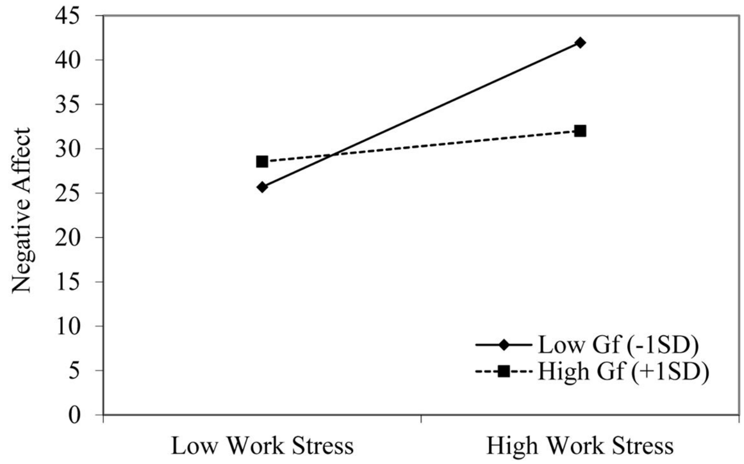
Wheaton, B. A checklist of ongoing difficult situations in domains of work, relationships, and financial strain. In: Avison, WR., Gotlib, IH., editors. Stress and mental health: Contemporary issues and prospects for the future. New York: Plenum Press; 1994. p. 77-114.

Wheaton, B. Psychosocial stress: Perspectives on structure, theory, life-course, and methods. San Diego, CA, US: Academic Press; 1996. The domains and boundaries of stress concepts; p. 29-70.

Wilhelm K, Kovess V, Rios-Seidel C, Finch A. Work and mental health. Social Psychiatry and Psychiatric Epidemiology. 2004; 39(11):866–873. [PubMed: 15549238]

Zachary, RA., Shipley, WC. Shipley institute of living scale: Revised manual. WPS, Western Psychological Services; 1986.

A. Moderating effect of fluid cognition (Gf)



B. Moderating effect of crystallized cognition (Gc)

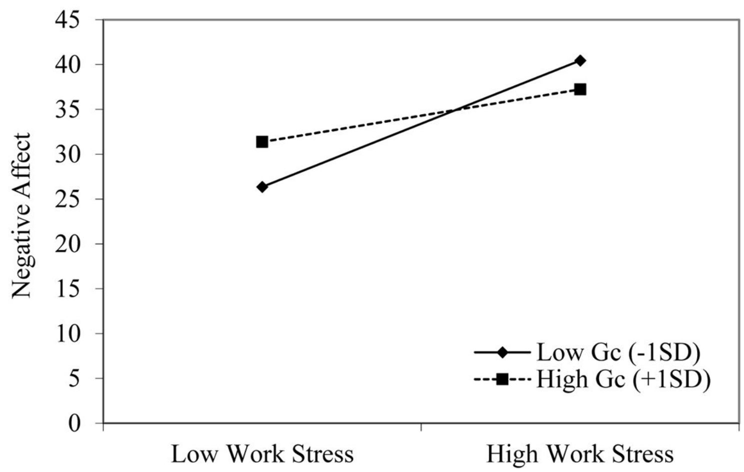


Figure 1.

Two way interactions between cognitive abilities and work stress predicting negative affect

Table 1

Descriptive data on demographic variables by working status and age group

	By working status			By age group among workers		
	Working (N=139)	**Non-working (N=149)**	***p***	**Younger (N=71)**	**Older (N=68)**	***p***
Age, Mean (SD)	45.6 (10.17)	48.8 (11.5)	0.01	37.1 (5.3)	54.5 (5.1)	<.001
Gender, % of female	69.1%	58.2%	0.057	67.6%	70.6%	0.704
Ethnicity, %						
Non-Hispanic White	8.6%	8.1%	0.597	4.2%	13.2%	0.020
Non-Hispanic Black	60.4%	59.1%		53.5%	67.7%	
Hispanic White	19.4%	19.5%		23.9%	14.7%	
Hispanic Black	8.6%	7.4%		12.7%	4.4%	
Asian	0.7%	-		1.4%	-	
Other	2.2%	6.0%		4.2%	-	
Education, %						
Some high school or less	5.0%	6.2%	0.002	7.0%	2.9%	0.335
Completed high school or some college	43.2%	62.3%		35.2%	51.5%	
Had a college degree	51.8%	31.5%		57.8%	45.6%	
Income, %						
<$20,000	8.6%	36.1%	0.000	11.3%	5.9%	0.937
$20,000 – $39,999	24.5%	21.5%		23.9%	25.0%	
$40,000 – $59,999	23.2%	17.4%		22.5%	23.0%	
$60,000 – $79,999	16.7%	9.0%		16.9%	16.2%	
$80,000 or more annually	20.1%	9.0%		19.7%	20.6%	
Declined to report	7.2%	6.9%		5.6%	8.8%	
Marital Status, %						
Married/partnered persons	32.4%	31.0%	0.809	28.2%	36.8%	<.001
Not married but living with someone	10.1%	8.3%		15.5%	4.4%	
Divorced or separated	19.4%	15.9%		12.7%	26.5%	
Never married	30.9%	35.2%		35.2%	26.5%	
Widowed	1.4%	3.5%		-	2.9%	
Other	5.8%	6.2%		8.5%	2.9%	

A median split (median age=45) was used to identify younger versus older group.

For the comparison of ethnicity, marriage, education, and income, Fisher's exact tests were conducted. Chi-square test was conducted for sex comparison and t-test was conducted for age comparison.

Table 2

Descriptive statistics and correlations among key variables

	M	*SD*	Range	1	2	3	4
1. Work Stress[a]	1.81	0.46	1–3	–			
2. Negative Affect	35.05	12.54	10–69	0.44**	–		
3. Gf[a]	21.70	5.04	5–30	0.09	−.05	–	
4. Gc[a]	29.47	5.06	14–40	0.00	0.04	0.52**	–
5. Age[a]	45.62	10.17	25–65	−0.17*	−0.10	−0.25**	0.07

*$p<.05$,

**$p<.01$.

Gf: Fluid cognition, Gc: Crystallized cognition.

[a]The raw values, instead of centered values (for work stress and age) and *z* standardized values (for Gf and Gc), were used to show descriptive statistics (M, SD) in this table. In the following analyses, centered values (for work stress and age) and *z* standardized values (for Gf and Gc) were used.

Table 3

Descriptive statistics of key variables by age group

	Younger (N=71)	Older (N=68)	t (*p*)
	M (SD)	***M (SD)***	
1. Work Stress [a]	1.90 (0.43)	1.71 (0.47)	2.54 (.010)
2. Negative Affect	37.11 (11.92)	32.90 (12.90)	2.00 (.047)
3. Gf [a]	23.03 (4.61)	20.30 (5.14)	3.29 (.001)
4. Gc [a]	29.46 (4.44)	29.49 (5.67)	−.02 (.980)

Gf: Fluid cognition, Gc: Crystallized cognition.

A median split (median age=45) was used to identify younger versus older group.

[a]The raw values, instead of centered values (for work stress and age) and *z* standardized values (for Gf and Gc), were used to show descriptive statistics (M, SD) in this table. In the following analyses, centered values (for work stress and age) and *z* standardized values (for Gf and Gc) were used.

Table 4

The effects of work stress and cognition predicting negative affect

	Age Model			Gf Model			Gc Model		
	Estimate	β	95% CI	Estimate	β	95% CI	Estimate	β	95% CI
Intercept	34.41	-	-	32.60	-	-	33.86	-	-
Work stress	1.94	0.40**	[6.65, 15.23]	1.73	0.39**	[6.58, 14.89]	1.84	0.39**	[6.66, 15.3]
Age	−0.12	−0.10	[−0.32, 0.8]	−0.16	−0.13	[−0.35, 0.4]	−0.15	−0.12	[−0.35, 0.4]
Gf				−1.77	−0.14	[−3.9, 0.35]			
Gc							0.45	0.04	[−1.59, 2.48]
Work stress × Age	0.14	0.04	[−0.35, 0.62]						
Work stress × Gf				−6.97	−0.25**	[−11.13, −2.81]			
Work stress × Gc							−4.48	−0.17*	[−8.64, −0.31]
Gender[a]	3.80	0.11	[−1.9, 7.25]	3.49	0.13	[−0.56, 7.54]	2.97	0.11	[−1.16, 7.1]
Education[b]									
Middle	−1.79	−0.07	[−1.67, 7.9]	0.35	0.01	[−8.3, 9]	−0.53	−0.02	[−9.35, 8.29]
High	−1.13	−0.05	[−9.92, 7.67]	1.48	0.06	[−7.27, 1.22]	−1.16	−0.05	[−1.7, 7.76]
Health limitations	0.47	0.22**	[0.12, 0.81]	0.36	0.17*	[0.2, 0.69]	0.50	0.23**	[0.16, 0.83]
F	6.44**			7.43**			6.44**		
R^2	0.26			0.32			0.28		
adjusted R^2	0.22			0.27			0.24		

* p<.05,

** p<.01.

Gf: Fluid cognition, Gc: Crystallized cognition.

Gender and education variables were dummy coded and the estimates indicate comparison to the reference category.

[a] Reference group: male,

[b] Reference group: low education.

Table 5

The effects of work stress, cognition, and age predicting negative affect

	Gf-Age Model			Gc-Age Model		
	Estimate	**β**	**95% CI**	**Estimate**	**β**	**95% CI**
Intercept	31.81	-	[23.3, 40.58]	35.43	-	[26.98, 43.89]
Work stress	10.99	0.40**	[6.4, 15.58]	10.63	0.39**	[6.51, 14.75]
Age	−0.17	−0.14	[−0.37, 0.3]	−0.13	−0.11	[−0.32, 0.6]
Gf	−2.04	−0.16	[−4.29, 0.22]			
Gc				0.30	0.02	[−1.72, 2.32]
Work stress × Age	−0.16	−0.05	[−0.7, 0.37]	0.35	0.11	[−0.14, 0.84]
Work stress × Gf	−7.30	−0.26**	[−12.56, −2.4]			
Work stress × Gc				−1.55	−0.06	[−6.29, 3.19]
Age × Gf	0.08	0.06	[−0.15, 0.3]			
Age × Gc				−0.16	−0.13	[−0.34, 0.3]
Work stress × Gf × Age	−0.01	0.00	[−0.55, 0.53]			
Work stress × Gc × Age				−0.82	−0.27**	[−1.38, −0.27]
Gender[a]	3.47	0.13	[−0.63, 7.56]	3.08	0.11	[−0.93, 7.9]
Education[b]						
Middle	0.91	0.04	[−7.97, 9.79]	−2.63	−0.10	[−11.3, 6.5]
High	1.68	0.07	[−7.24, 1.61]	−2.56	−0.10	[−11.27, 6.15]
Health limitations	0.34	0.16	[−0.2, 0.69]	0.46	0.21**	[0.12, 0.79]
F	5.41**			6.3**		
R^2	0.32			0.34		
adjusted R^2	0.26			0.29		

* $p<.05$,

** $p<.01$.

Gf: Fluid cognition, Gc: Crystallized cognition.

[a] Reference group: male,

[b]Reference group: low education.