Findings on the relationship between engagement in lifestyle and cognitive functioning are not consistent; some authors report that engagement in lifestyle predicts an individual’s cognitive functioning; while others report that an individual’s cognitive functioning predicts the type and level of engagement an individual participates in. The current study used longitudinal data ($N = 235$) to investigate the bidirectional relationship between engagement (engaged lifestyle activities) and cognition (crystallized & fluid intelligence). Despite inconsistent findings, it is proposed that cognitive functioning may be better understood when examining how stimulation of activity, need for cognition, and openness to experience affect engagement in an active lifestyle. As such the current study investigated if stimulation of activity, need for cognition, and openness to experience moderate the relationship between engaged lifestyles and cognitive functioning. The results, limitations, and implications are discussed.
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Bashir Abdullah
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CHAPTER 1
INTRODUCTION

In recent decades, there has been an increased interest in the effects of cognitive decline in the older populations (Langa et al., 2008). This rise in interest is understandable considering the global prevalence of dementia, or decline in memory and other cognitive functions that leads to a loss of independent function, is estimated to be 35.6 million in 2010, with the number expected to reach approximately 65 million in 2030 and 115 million in 2050 with dementia (Alzheimer's Disease International, 2009). Over the past century we have seen a greater increase in life expectancy of individuals (Bunker et al., 1999). The increase of 30 plus years can be attributed to medical advancements and education. However, this increase in life expectancy has helped to identify various problems in later life. One of those being an increase in older populations is that there have been more people identified with alzheimer’s disease.

As the world ages and declines in functioning, difficulties with memory, attentional control, and language understanding can hinder an aging individual from participating in everyday life (Small et. al, 2012). Research has shown a cognitive decline over later life (Schaie, 2005, Salthouse, 1992, Salthouse, 2006). Salthouse (2004) performed a metanalysis looking at 33 separate studies and concluded through factor analysis a linear decline in reasoning, spatial visualization, episodic memory, and perceptual speed in older aged populations. However, Salthouse found a positive relationship between vocabulary knowledge and age. He attributed the relationship to an increase in life experiences and opportunities to gain information.

Schaie, Willis, & O’Hanlon (1994) findings had shown that self-perceptions of cognitive change in older adults over a seven-year period generally were accurate. Individuals did not predict change in their performance equally across abilities measured (Verbal meaning, spatial
orientation, Inductive reasoning, Number addition, & Word fluency) and there appeared to be an age and gender interaction that moderated accuracy of perceptions.

Some research (Lachman et. al, 1979; Lachman & Jelalian, 1984) suggested individuals who performed well on specific ability measures were more accurate in their estimates of performance. However, Schaie et. al did not replicate this finding.

Hayslip & Cooper (2012) looked at perceived estimates & actual measures of fluid (Gf) and crystallized intelligence (Gc) over a three-year period. What the older adults attributed the change in their intelligence was also investigated. They found individuals’ subjective estimate of a mild decline in vocabulary and fluid skills mirrored objective change. Findings were consistent with the importance of engaging in a physically active and thought-provoking novel tasks that were challenging in nature to maintain and enhance one’s cognitive skills. Participants attributed change to factors they had greater internal locus of control (i.e., nutrition, health, and their own effort) and attributed less of the change to factors out of their control (i.e., aging process, external characteristics, genetic predisposition). Participants remained hopeful about positive changes in their integrity of their skills.

Hertzog & Touron (2011) looked at memory deficits and confidence level of retrieval memory of older adults compared to younger adults. Older adults displayed lower confidence in memory recall and this was associated with a decrease in accuracy of recall. Hertzog & Touron made the further argument that this was due to a slower rate of associative learning.

Salthouse’s (1985) originally proposed a theory of cognitive aging that found that older adult’s decline in cognitive functioning could be accounted for by slower processing speed. He found that older individuals lacked enough time to carry out their cognitive processes. He later provided more evidence of the processing-speed theory by showing a negative correlative
relationship between age and processing with the Wechsler Adult Intelligence Scale-Revised (Salthouse, 1992). Salthouse (1991) also postulated that adults that failed to continue to engage in active lifestyles were found to be at a greater risk of cognitive functioning through atrophy of cognitive processes and skills. Salthouse briefly explored some of the risks factors that are associated with cognitive decline (e.g., failure to adapt to new situations, integrating new data, formulating new associations, inability to organize information & solve novel problems).

Risk Factors for Cognitive Decline

Biological Influences

Engagement and activities may be driven by genetic constraints that closely align with potential for cognitive vitality (Williams, 2010). Early educational experiences create additional neuronal pathways to provide alternatives to typical brain development. While plasticity studies have shown cognitive training positively effecting cognitive abilities across life span, some research has shown benefits are rarely able to generalize broadly across skills (Hayslip, 1989).

Other studies have looked at the relationship between cognitive decline and metabolic syndrome. National Institutes of Health (2013) defines metabolic syndrome (MS) as a group of risk factors that raises your risk for heart disease and other health problems, such as diabetes and stroke. The Yaffe et. al (2004) study investigating 2632 older adults found that individuals with MS exhibited higher cognitive decline compared to those without. The Ho et al. (2008) and Knopman et al. (2009) findings replicated cognitive decline being due to MS.

Physical Exercise

Research has shown that physical activity helps to compensate for some the cognitive declines in aging populations (Yaffe, 2001). Previous research has used yoga, aerobie, and nonaerobic tasks to investigate the relationship physical activity and cognitive ability
They found over the four months of physical training, their aerobic group showed no improvement in cognitive transfer tasks than the yoga and control group. While investigating executive control processes in 124 individuals between 60 and 75 years old, Kramer et al. (1999) found improvement with an aerobic training group in selective attention, task switching, and inhibition after 6 months of training when compared to a toning control group. Additionally, Colcombe et al. (2006) found that aerobic exercise in older adult participants resulted in an increased volume of gray and white material within prefrontal and temporal regions of the brain. Moreover, they did not find any significant differences for younger participants.

Lifestyle

Observational studies done by Berr et al. (2000) have shown small to moderate effect sizes with risk of cognitive decline with low plasma selenium. Selenium is an antioxidant that helps provides the maintenance of brain functions (Williams et al., 2010). Berr et al. discussed the relationship of between selenium reduction and a 3-point decrease in performance in the Mini Mental State Exam (MMSE) across a 4-year follow-up. This modest effect necessitates further investigation. Akbaraly et al. (2007) discussed how reduced long-term selenium lead to an decrease in performance of the MMSE at 9 years. Higher amounts of vegetable intake, adherence to a Mediterranean diet, and higher levels of omega-3 fatty acids showed a likely association with decreased risk of cognitive decline, but evidence was limited for some of these factors (Heude et al., 2003, Beydoun et. al, 2007, & Beydoun et. al, 2008).
Coping with Cognitive Decline

Studies have revealed there is a great deal of variability in the aging process (Nelson & Dannefer, 1992). Schaie (2005) reports that cognitive functioning is variable and changes across the life span. Although some cognitive decline is inevitable as individuals age (Burns, & Zaudig, 2002), preventative measures can be taken to minimize the decline to some extent. Aging adults have choices in the way they allocate effort in everyday mental tasks that either help or hinder their cognitive functioning. They can compensate for subtle age-related changes rather than either giving in to them or giving up completely on the activity (Baltes & Baltes, 1990; Baltes & Carstensen, 1996). Elderly individuals also have choices in the way they stay mentally engaged and embrace challenges throughout their lifetimes and into older age. This process has been named the Dumbledore hypothesis of cognitive aging (Stine-Morrow, 2007).

Many adults can also enhance or prevent further declines in such skills they have through selection, optimization, and compensation (SOC, Baltes & Baltes, 1990; Baltes & Carstensen, 1996). The Selection Optimization and Compensation model reflects older persons’ selection of key skills, optimization of these skills through practice, so that they can compensate for declines in other skills or skill areas. Research found that cognitive and physical abilities can increase or decrease across the life span, because people use goals and practice strategies to improve or maintain skills or abilities they value. Successful aging follows a framework of gains and losses. Further research on resource allocations is needed.

As current research shows a relationship between active lifestyles and positive health, longevity, and cognitive functioning (Salthouse, 2006), it is important to further explore influences on such relationships (Crowe et al., 2006; Frerichs & Tuokko, 2006). Confounding variables make experimental control an important factor in determining or isolating accurate
estimates of changes in cognitive functioning (experiences, level of education, cardiovascular, and socioeconomic status). The Nun study (Snowdon, 2003) funded by National Institutes of Health (NIH) aimed to limit confounding variables by studying cognitive decline in 678 Catholic sisters that ranged from 75 to 102 years in age. Findings suggested that the severity of pathology in the brain and the individual’s resistance to expression of neuropathology was related to healthy aging.

Engagement: One Form of Coping

Using longitudinal data Hultsch et al. (1999) found that cognitive enriching engagement led to changes in cognitive functioning. This postulated the “Use it or Lose it” theory similarly to the Speed-processing theory of Salthouse. Additionally, level of engagement had been found to effect cognition in later life. Hultsch et al. (1999) measured engagement by a variety list of everyday activities such as physical activities, social activities, hobbies, passive information processing, and novel information processing. Engagement has more recently been associated as a buffer against typical cognitive declines across the life span (Hertzog et al., 2008). Cognitive abilities such as working-memory capacity and speed of processing information powerfully contribute to cognitive vitality, as does performance in complex activities such as problem solving and language understanding. Hertzog et al. (2010) demonstrated older adult’s implicit memory strategies were consistent with the “Use it or lose it” theory; a viewpoint with supporting literature (Einstein & McDaniel, 2004; Hertzog, Kramer, Wilson, & Lindenberger, 2009; Stine-Morrow, 2007).

Challenging Tasks

Some evidence suggests that individuals embedded in contexts providing regular opportunities for intellectual challenge, such as environments that require an individual to
formulate solutions to problems and other stimulating activities, fare better along a number of dimensions (Hultsch et al., 1999; Salthouse, 2006). They are likely to live longer, be more resistant to psychological manifestations of age-related pathological processes, and score better on measures of cognitive performance (Lennartsson & Silverstein, 2001; Wilson et al., 2002)). Effects may be due to individuals seeking out experiences where they can excel (ie. solving crossword puzzles, learning to play an instrument).

Computer-Based Activities

Research has shown there is possibly noteworthy work that is being achieved with computer-assisted activities like video games (Green & Bavelier, 2003, 2006, 2007). They found that younger adults improved their perceptual and attentional skills after training as little as 10 hours on action videogames. The games required individuals to be engaged intellectually, socially, and sometimes emotionally. There are mixed results regarding the effects of performing perceptual and attentional skills tasks within video games on cognitive functioning. For example, Goldstein et al. (1997) found that older adults who had video game training did not improve in the Stroop Color Word Test, but did improve in the Sternberg reaction time task compared to non-gamers. Additionally, Boot et al. (2008) found in a sample of 20 participants, who played 20 hours of training video games, no direct benefits across a series of cognitive measures. Research found that when older adults played games that were more generationally appropriate for them there was no improvement in executive control processes but a reduction in response times (Clark et al., 1987, Dustman et al., 1992). To better understand the potential usefulness of computer-based aids to cognitive functioning, additional studies are needed. Future studies can investigate motor response improvements and cognitive functioning in individuals that engage in computer-assisted activities.
Personality

While investigating 229 older participants, Hultsch et al. (1999) found there may be some personality characteristics (i.e., NEO-PI, Costa & McCrae, 1992) associated with individuals that buffers cognitive decline. Hultsch et al. initially found that agreeableness, conscientiousness, and neuroticism did not buffer cognitive decline. Subsequently, they found that extroversion and openness to experience offered a greater opportunity to prevent cognitive decline across later life. Research has shown that extroversion and openness did show some limited positive influence on cognitive change (Hultsch et al, 1999). Furthermore, extroversion and openness were significantly positively related to intellectually stimulating activities. There is little evidence for agreeableness, conscientiousness, and neuroticism contributing to cognitive change. Research shows that individuals with higher cognitive functioning early in life tended to have an affinity for activities that were mentally, physically, and socially stimulating across the life span.

Depression has been linked to an increased risk of Alzheimer’s disease, as well as cognitive decline (Williams et al., 2010). Ownby et al. (2006) conducted a meta-analysis of 20 studies investigating depression and cognitive decline. Cohort studies within that analysis exhibited a 1.90 to 2.03 odds ratio with depression and risk of Alzheimer’s disease. Other studies have shown depression to be a significant predictor of AD and dementia (Gatz et al., 2005; Geerlings et al., 2008; Irie et al., 2008; Lu et al., 2009; Luschinger et al., 2008).

Purposes of the Present Study

In this context, the primary investigator has collected data from community-residing older adults examining the influences on engaged lifestyles, utilizing a range of activities which may be for some persons and not others, cognitively stimulating and therefore potentially beneficial in this respect. The importance of attending to variability in such activities is
supported by data presented by Salthouse (2006) suggesting the cognitively challenging value of different everyday activities (e.g. reading, writing, shopping, doing housework, driving) and their frequency of participation varies across persons in adulthood.

In the context of variability across persons, preliminary analyses of these data to date suggest 1) that there is considerable variability across 81 engaging activities among older adults in both their participation and in their perceived mentally stimulating potential, 2) that attitudes toward engaging in cognitively stimulating activities could be reliably assessed and are factorially complex, and 3) that personality (openness to experience, extroversion) made the greatest unique contribution to predicting engaged lifestyle involvement, while measures of cognitive functioning did not uniquely predict such involvement, though they correlated with lifestyle activities (Anton, Hayslip, 2008; Hayslip, Maiden, Anton, & Halpin, 2008; Maiden, Hayslip, Anton, & Halpin, 2008). In light of these preliminary findings, the current study formulated two hypotheses focused on the relationships between engaged lifestyle activities and cognition. The hypotheses were designed to tease out the strength and direction of such relationships.

Objectives

The current study looks to fulfill three major objectives. First, the project seeks to provide descriptive data regarding frequency of engagement and stimulation. Second, the project explores direction of causation over time. Third, the project seeks to find what an engage lifestyle’s impact on cognition as a function of our other intervening variables (openness to experience, need for cognition, stimulation value) during phase 1 and phase 2.
Hypotheses

1. It is predicted that the overall engagement in lifestyle score at time 1 will predict fluid intelligence at time 2.

2. It is predicted that the overall engagement in lifestyle score at time 1 will predict crystallized intelligence at time 2.

3. It is predicted that the hypothesized factors of engagement in lifestyle at time 1 will predict fluid intelligence at time 2.

4. It is predicted that the hypothesized factors of engagement in lifestyle at time 1 will predict crystallized intelligence at time 2.

5. Interaction term of stimulation in activity, need for cognition, and openness to experience will moderate the effect that overall engagement in lifestyle score has on fluid intelligence at time 1 and time 2.

6. Interaction term of stimulation in activity, need for cognition, and openness to experience will moderate the effect that hypothesized factors of engagement in lifestyle has on fluid intelligence at time 1 and time 2.

7. Interaction term of stimulation in activity, need for cognition, and openness to experience will moderate the effect that overall engagement in lifestyle score has on crystallized intelligence at time 1 and time 2.

8. Interaction term of stimulation in activity, need for cognition, and openness to experience will moderate the effect that hypothesized factors of engagement in lifestyle has on crystallized intelligence at time 1 and time 2.
CHAPTER 2

METHODS

Participants

Wave 1 participants included 619 older adults, aged 49 to 92 years ($M = 71.83$, $SD = 9.09$ years). The majority of participants reported being female (70%), having a low income (50% below $35,001 earned in the last 12 months), and most were married (54%), although, 30% of participants reported being widowed. Approximately 300 Wave 1 participants reported being willing to participate in future waves. Wave 2 participants included 263 (42%) older adults ranging in age from 50 to 93 years ($M = 73.44$, $SD = 8.71$ years).

Wave 2 data was collected between 18 and 24 months after the completion of Wave 1 data collection. The majority of participants reported being female (75%), having a low income (46% below $35,001 earned in the last 12 months), and most were married (50%), although 33% of participants reported being widowed. Funding for participant compensation at Wave 2 included $5.00. Participants who returned surveys with incomplete data were not compensated and that data was not entered into the data file.

Attrition analysis revealed no significant differences between participants who chose to participate in Wave 2 and those who did not on openness to experience. Attrition analysis revealed significant differences at Wave 1 between participants who chose to participate in Wave 2 and those who did not on most variables under investigation. Those who participated in both waves scored higher ($M = 27.99$, $SD = 5.74$) than those who participated in Wave 1 only ($M = 25.53$, $SD = 5.78$) on the openness to experience scale, $t(617) = 5.23$, $p < .001$. Those who participated in both waves scored higher ($M = 8.48$, $SD = 2.09$) than those who participated in Wave 1 only ($M = 7.79$, $SD = 2.30$) on the common analogies scale, $t(617) = 3.84$, $p < .001$. 
Those who participated in both waves scored higher ($M = 9.46$, $SD = 2.42$) than those who participated in Wave 1 only ($M = 8.23$, $SD = 3.02$) on the abstruse analogies scale, $t(617) = 5.61$, $p < .001$. Those who participated in both waves scored higher ($M = 8.42$, $SD = 3.44$) than those who participated in Wave 1 only ($M = 6.92$, $SD = 4.04$) on the letter series scale, $t(617) = 4.96$, $p < .001$. Those who participated in both waves scored higher ($M = 4.85$, $SD = 2.75$) than those who participated in Wave 1 only ($M = 3.49$, $SD = 2.94$) on the letter sets scale, $t(617) = 5.90$, $p < .001$. Those who participated in both waves scored higher ($M = 13.00$, $SD = 2.33$) than those who participated in Wave 1 only ($M = 12.14$, $SD = 2.98$) on the vocabulary scale, $t(617) = 4.03$, $p < .001$. Those who participated in both waves scored higher ($M = 190.18$, $SD = 24.33$) than those who participated in Wave 1 only ($M = 177.99$, $SD = 25.93$) on the engagement activities scale, $t(617) = -5.93$, $p < .001$. All of these differences revealed that participants who did not choose to participate at Wave 2 scored slightly lower on the variables under investigation. The pattern of total score correlations among key variables was also compared between those who participated in Wave 1 only and those who participated in both waves. Correlations between total engagement, crystallized intelligence, fluid intelligence, extroversion, and openness to experience were all similar in direction and significance between those who participated at Wave 1 only and those who participated in both waves. Only one correlation notably different; the relationship between extroversion and openness was significant with participants who participated in both waves, while it was not significant with participants who participated at Wave 1 only.
Measures

Both Wave 1 and Wave 2 older adults provided data regarding the extent of their participation in 81 everyday activities. The Activities of Engagement (Maiden et al., 2008) were assembled from previous literature (Arbuckle et al., 1998; Hultsch et al., 1999; Bosma et al., 2002) and were considered mentally stimulating (e.g. household tasks, writing, driving, playing a musical instrument, doing crossword puzzles, managing one’s medication, doing one’s own taxes, playing bingo; alpha = .87). For the purpose of this project, an index score of all activity will be created by summing all activities to create an overall score of engagement in lifestyle.

Hypothesized factors of engagement lifestyle include hobbies, physical activity, passive information processing, self-maintenance, and novel information processing (esoteric, everyday, and cognitive). Factor clusters were used by previous research (Hultsch et al., 1999; Bosma et al., 2002). For further explanation of these clusters, please see the appendix.

Pursuant of the “use it or lose it” hypothesis that states age deficits of cognitive performance can be moderated by individual lifestyles like cognitive stimulation (Hultsch et al., 1999; Salthouse, 2002), participants were asked to rate how stimulating these activities were (1 = Not at all, 2 = Somewhat, 3 = Very).

Participants completed a need for cognition scale (Cacioppo et al., 1982) that was comprised of 17 items that were to be rated between strongly agree and strongly disagree. Sample items include “I would prefer complex to simple problems” and “I find satisfaction in deliberating hard and for long hours.”

Participants also completed measures of fluid (letter series, letter sets, common analogies) and crystallized (vocabulary, abstruse analogies) intelligence (15 items each, all scored as 1 = correct, 0 = incorrect, alphas > .80; Hayslip, 1977, 1979-1980; Hayslip & Sterns,
Fluid intelligence is related to process oriented aspects of the verbal and performance subtests of the Wechsler Adult Intelligence Scale-Revised (WAIS-R), while crystallized intelligence is more related to verbal oriented content of the WAIS-R (Horn, 1978a; Horn, 1978b; Cattell & Horn, 1978). Research suggests fluid intelligence, the ability to solve problems, puzzles, and abstract reasoning, tends to decline throughout adulthood, while crystallized intelligence; the accumulated knowledge of learning (both formal and informal) does not decrease until later life, after approximately age 60 (Kaufman & Horn, 1996). Newer research suggests that previously identified age related declines in fluid intelligence can be nullified with gaining expertise, particularly intensive practice (Masunaga & Horn, 2001).

Participants also completed measures of extroversion and openness to experience (12 items each) derived from the Neuroticism, Extroversion, Openness-Personality Inventory (NEOPI; Costa & McCrae, 1992). The NEO-PI is a well-established self-report personality inventory which has five central traits for assessing normal personality; neuroticism (N; alpha = .93) extroversion (E; alpha = .87), openness to experience (O; alpha = .89), agreeableness (A; alpha = .76), and conscientiousness (C; alpha = .86). Sixty rationally constructed test items each have a five point Likert scale response format from 0 = disagree strongly to 4 = agree strongly. Siegler and Brummett (2000) have found that psychological well-being was negatively related to N, positively related to E, and positively related to C. Weiss et al. (2005) have found that only A distinguishes between old-old and young or young-old participants, with old-old participants scoring significantly higher. More recently, Terracciano, McCrae, Brant, and Costa (2005) have found “gradual personality changes in adulthood: a decline in N up to age 80, stability and then decline in E, decline in O, increase in A, and increase in C up to age 70” (p. 493). However, Terracciano et al. admit these changes are modest and required a notably large sample and a
substantial amount of longitudinal data collection (i.e. time). Some limited data has been collected speaking to relationships between some NEO factors and mortality. For example, Wilson, Mendes de Leon, Bienias, Evans, and Bennett (2004) have found significantly increased rates of mortality among longitudinally followed elders who scored high for N and low in C. Wilson et al. did notice a significant relationship between mortality rates and E, with lower E related to higher mortality. However, Wilson et al. also recognize that the participants in their study who died tended to be older and have lower levels of health status and functioning.

Each of these measures of cognitive functioning and personality has established reliability and validity, and have respectively, been utilized in many published studies of intellectual functioning (see above, as well as Hayslip, 1988, 1989, Hayslip, Maloy, & Kohl, 1995), as well as personality and aging (see Costa & McCrae, 1992; Mroczek, Spiro, & Griffin, 2006). These measures were administered through postal mail for the current project.

Proposed Data Analyses

Descriptive Statistics

First, descriptive information on demographic characteristics, such as age, gender, education level, socioeconomic status, and ethnicity will be reported. Second, mean scores, standard deviations, and/or frequency counts for the sample on the above measures will be reported. In addition, internal consistency reliability estimates will be obtained for each of the measures in the sample.

Data Preparation and Preliminary Analyses

The data will be analyzed using SPSS. Prior to data analyses, the data will be assessed for missing data and outliers. Assumptions of linearity, homoscedasticity, and normality will be evaluated. If any of these assumptions are violated, data transformations will be utilized. The
alpha for each of the measures will be determined to assess the internal consistency of each
measure in the present sample of participants. The hypotheses will then be tested using a series
of correlations and simultaneous multiple regressions.

Proposed Data Analyses for Hypotheses Testing

The following analyses are proposed to test hypotheses:

1. It is predicted that the overall engagement in lifestyle score at time 1 will predict fluid
   intelligence at time 2.
   
   a. Stationary of the relations between overall engagement in lifestyle score and fluid
      intelligence indices were addressed via a Steiger’s Z-test of the synchronous
      correlations (Meng, Rosenthal, & Rubin, 1992). Relations among Time 1 and
      Time 2 overall engagement in lifestyle score and fluid intelligence were then
      examined via three cross-lagged panel correlations (e.g. Kenny, 1975; Kenny &
      Harackiewicz, 1979; Locascio, 1982). Next, all predictor variables were
      standardized and simultaneous regression analyses were conducted.

2. It is predicted that the overall engagement in lifestyle score at time 1 will predict
   crystallized intelligence at time 2.
   
   a. Stationary of the relations between overall engagement in lifestyle score and
      crystallized intelligence indices were addressed via a Steiger’s Z-test of the synchronous
      correlations (Meng, Rosenthal, & Rubin, 1992). Relations among
      Time 1 and Time 2 overall engagement in lifestyle and crystallized intelligence
      were then examined via three cross-lagged panel correlations (e.g. Kenny, 1975;
      Kenny & Harackiewicz, 1979; Locascio, 1982). Next, all predictor variables were
      standardized and simultaneous regression analyses were conducted.
3. It is predicted that the hypothesized factors of engagement in lifestyle at time 1 will predict fluid intelligence at time 2.
   a. Stationary of the relations between hypothesized factors of engagement in lifestyle and fluid intelligence indices were addressed via a Steiger’s Z-test of the synchronous correlations (Meng, Rosenthal, & Rubin, 1992). Relations among Time 1 and Time 2 hypothesized factors of engagement in lifestyle and fluid intelligence were then examined via three cross-lagged panel correlations (e.g. Kenny, 1975; Kenny & Harackiewicz, 1979; Locascio, 1982). Next, all predictor variables were standardized and simultaneous regression analyses were conducted.

4. It is predicted that the hypothesized factors of engagement in lifestyle at time 1 will predict crystallized intelligence at time 2.
   a. Stationary of the relations between hypothesized factors of engagement in lifestyle and crystallized intelligence indices were addressed via a Steiger’s Z-test of the synchronous correlations (Meng, Rosenthal, & Rubin, 1992). Relations among Time 1 and Time 2 hypothesized factors of engagement in lifestyle and crystallized intelligence were then examined via three cross-lagged panel correlations (e.g. Kenny, 1975; Kenny & Harackiewicz, 1979; Locascio, 1982). Next, all predictor variables were standardized and simultaneous regression analyses were conducted.

5. Interaction term of stimulation in activity, need for cognition, and openness to experience will moderate the effect that overall engagement in lifestyle score has on fluid intelligence at time 1 and time 2.
a. In order to test this hypothesis and to test the moderator effect, a moderation analysis will be conducted as outlined in Frazier, Tix, and Barron (2004). The first step will be to standardize and center the predictor variables by subtracting the sample means to produce revised sample means of zero. After centering each variable, a product term will be created to represent the interaction between the independent variable (overall engagement in lifestyle score) and the moderator variable (stimulation of activity, need for cognition, and openness to experience). Multiplying the centered overall engagement in lifestyle score variable with the centered stimulation of activity & need for cognition term variable will create the product term (Frazier et al., 2004). The final step of the moderation analysis will be a simultaneous multiple regression. To do this, the predictor variable will be entered into the regression equation through a series of specified blocks. The first step/block of the regression will contain the overall engagement in lifestyle score (independent variable). The second step will contain the stimulation of activity, need for cognition, openness to experience term (moderator variable). The third step will contain the product term that represents the interactions of the overall engagement in lifestyle score and stimulation of activity, need for cognition, openness to experience (Frazier et al., 2004). Sample size, the correlation matrix, \( \text{Adj. } R^2 \), \( B \), and \( \text{Beta} \) will be reported for each analysis. The change in \( R^2 \) and its statistical significance will also be reported. Moderation will be assumed if the interaction term contributes significantly to the variance in the fluid intelligence at time 1.
6. Interaction term of stimulation in activity, need for cognition, and openness to experience will moderate the effect that hypothesized factors of engagement in lifestyle has on fluid intelligence at time 1 and time 2.

a. In order to test this hypothesis and to test the moderator effect, a moderation analysis will be conducted as outlined in Frazier, Tix, and Barron (2004). The first step will be to standardize and center the predictor variables by subtracting the sample means to produce revised sample means of zero. After centering each variable, a product term will be created to represent the interaction between the independent variable (hypothesized factors of engagement in lifestyle) and the moderator variable (stimulation of activity, need for cognition, and openness to experience). Multiplying the centered hypothesized factors of engagement in lifestyle variable with the centered stimulation of activity & need for cognition term variable will create the product term (Frazier et al., 2004). The final step of the moderation analysis will be a simultaneous multiple regression. To do this, the predictor variable will be entered into the regression equation through a series of specified blocks. The first step/block of the regression will contain the hypothesized factors of engagement in lifestyle (independent variable). The second step will contain the stimulation of activity, need for cognition, and openness to experience term (moderator variable). The third step will contain the product term that represents the interactions of the hypothesized factors of engagement in lifestyle and stimulation of activity, need for cognition, and openness to experience (Frazier et al., 2004). Sample size, the correlation matrix, $Adj. R^2$, $B$, and $Beta$ will be reported for each analysis. The change in $R^2$ and its
statistical significance will also be reported. Moderation will be assumed if the interaction term contributes significantly to the variance in the fluid intelligence at time 1.

7. Interaction term of stimulation in activity, need for cognition, and openness to experience will moderate the effect that overall engagement in lifestyle score has on crystallized intelligence at time 1 and time 2.

   a. In order to test this hypothesis and to test the moderator effect, a moderation analysis will be conducted as outlined in Frazier, Tix, and Barron (2004). The first step will be to standardize and center the predictor variables by subtracting the sample means to produce revised sample means of zero. After centering each variable, a product term will be created to represent the interaction between the independent variable (overall engagement in lifestyle score) and the moderator variable (stimulation of activity, need for cognition, and openness to experience). Multiplying the centered overall engagement in lifestyle score variable with the centered stimulation of activity & need for cognition term variable will create the product term (Frazier et al., 2004). The final step of the moderation analysis will be a simultaneous multiple regression. To do this, the predictor variable will be entered into the regression equation through a series of specified blocks. The first step/block of the regression will contain the overall engagement in lifestyle score (independent variable). The second step will contain the stimulation of activity, need for cognition, and openness to experience term (moderator variable). The third step will contain the product term that represents the interactions of the overall engagement in lifestyle score and stimulation of activity, need for
cognition, and openness to experience (Frazier et al., 2004). Sample size, the
correlation matrix, \( Adj. R^2 \), \( B \), and \( Beta \) will be reported for each analysis. The
change in \( R^2 \) and its statistical significance will also be reported. Moderation will
be assumed if the interaction term contributes significantly to the variance in the
crystallized intelligence at time 1.

8. Interaction term of stimulation in activity, need for cognition, and openness to experience
will moderate the effect that hypothesized factors of engagement in lifestyle has on
crystallized intelligence at time 1 and time 2.

a. In order to test this hypothesis and to test the moderator effect, a moderation
analysis will be conducted as outlined in Frazier, Tix, and Barron (2004). The first
step will be to standardize and center the predictor variables by subtracting the
sample means to produce revised sample means of zero. After centering each
variable, a product term will be created to represent the interaction between the
independent variable (hypothesized factors of engagement in lifestyle) and the
moderator variable (stimulation of activity, need for cognition, and openness to
experience). Multiplying the centered hypothesized factors of engagement in
lifestyle variable with the centered stimulation of activity & need for cognition
term variable will create the product term (Frazier et al., 2004). The final step of
the moderation analysis will be a simultaneous multiple regression. To do this, the
predictor variable will be entered into the regression equation through a series of
specified blocks. The first step/block of the regression will contain the
hypothesized factors of engagement in lifestyle (independent variable). The
second step will contain the stimulation of activity, need for cognition, and
openness to experience term (moderator variable). The third step will contain the product term that represents the interactions of the hypothesized factors of engagement in lifestyle and stimulation of activity, need for cognition, and openness to experience (Frazier et al., 2004). Sample size, the correlation matrix, \( Adj. R^2 \), \( B \), and \( Beta \) will be reported for each analysis. The change in \( R^2 \) and its statistical significance will also be reported. Moderation will be assumed if the interaction term contributes significantly to the variance in the crystallized intelligence at time 1.
Hypothesis 1

Hypothesis 1 stated that the overall engagement in lifestyle score at time 1 would predict fluid intelligence at time 2. Initial analysis of the hypothesis was analyzed through a Pearson product-moment correlation between the composite overall engagement in lifestyle score at time 1 and fluid intelligence at time 2. As can be seen in Table 1, the results supported the hypothesis.

The hypothesis that overall engagement at time 1 would predict fluid intelligence at time 2 while controlling for overall engagement at time 2 was analyzed through three cross-lagged panel correlations. The predictor variable was the total score of the Overall Engagement Scale at time 1 while controlling for Overall Engagement at time 2, and the dependent variable was the total score compiled by the fluid intelligence scale at time 2. As can be seen in Figure 1, the partial correlation for fluid intelligence at time 1 predicting overall engagement at time 2, while controlling for overall engagement at time 1 was not significant. In addition, the hypothesis that overall engagement in lifestyle at time 1 would predict fluid intelligence at time 2 was not significant when we controlled for overall engagement at time 2.
Table 1

*Bivariate Correlations among Total Scores*

<p>| | | | | | | | | | | | |</p>
<table>
<thead>
<tr>
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<td>3. FI T1</td>
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<td>4. FI T2</td>
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<td>.90</td>
<td>.141*</td>
<td>.182**</td>
<td>.735**</td>
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<td>.177**</td>
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<td>.510**</td>
<td>.362**</td>
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<td>6. CI T2</td>
<td>22.59</td>
<td>4.21</td>
<td>.84</td>
<td>.164*</td>
<td>.186**</td>
<td>.402**</td>
<td>.502**</td>
<td>.468**</td>
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<td>7. NC T1</td>
<td>45.44</td>
<td>8.42</td>
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<td>-.122</td>
<td>-.118</td>
<td>.166*</td>
<td>.032</td>
<td>.018</td>
<td>.081</td>
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<td>8. NC T2</td>
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<td>5.23</td>
<td>.90</td>
<td>.136*</td>
<td>.108</td>
<td>.145*</td>
<td>.184**</td>
<td>.101</td>
<td>.346**</td>
<td>-.009</td>
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<td>9. SA T1</td>
<td>152.94</td>
<td>37.50</td>
<td>.94</td>
<td>.024</td>
<td>-.009</td>
<td>-.019</td>
<td>.016</td>
<td>.032</td>
<td>-.020</td>
<td>-.230**</td>
<td>-.061</td>
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<td>10. SA T2</td>
<td>160.34</td>
<td>37.33</td>
<td>.94</td>
<td>.283**</td>
<td>.349**</td>
<td>.261**</td>
<td>.357**</td>
<td>.171*</td>
<td>.300**</td>
<td>-.096</td>
<td>.248**</td>
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<tr>
<td>11. OE T1</td>
<td>28.06</td>
<td>5.86</td>
<td>.75</td>
<td>.340**</td>
<td>.303**</td>
<td>.254**</td>
<td>.089</td>
<td>.249**</td>
<td>.187**</td>
<td>.087</td>
<td>.047</td>
</tr>
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<td>12. OE T2</td>
<td>27.87</td>
<td>5.79</td>
<td>.76</td>
<td>.270**</td>
<td>.330**</td>
<td>.226**</td>
<td>.180**</td>
<td>.198**</td>
<td>.249**</td>
<td>.055</td>
<td>.066</td>
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</table>

Note. $N = 235$; * $p < .05$; ** $p < .01$. OA = Overall Activities; FI = Fluid Intelligence; CI = Crystallized Intelligence; NC = Need for Cognition; SA = Stimulation in Activity; OE = Openness to Experience.
Figure 1. The fluid intelligence structural model for correlations (cross-lagged); $N = 235$; $^* p < .05$; $^{**} p < .01$. 

Overall Activity
Time 1

Overall Activity
Time 2

Fluid Intelligence
Time 1

Fluid Intelligence
Time 2

**.79

**.17

.14 (.02)

.04 (.01)

.73

**.18
Hypothesis 2

Hypothesis 2 stated that the overall engagement in lifestyle score at time 1 would predict crystallized intelligence at time 2. Initial analysis of the hypothesis was analyzed through a Pearson product-moment correlation between the composite overall engagement in lifestyle score at time 1 and crystallized intelligence at time 2. As can be seen in Table 1, the results supported the hypothesis.

The hypothesis that overall engagement at time 1 would predict crystallized intelligence at time 2 while controlling for overall engagement at time 2 was analyzed through three cross-lagged panel correlations. The predictor variable was the total score of the Overall Engagement Scale at time 1 while controlling for Overall Engagement at time 2, and the dependent variable was the total score compiled by the crystallized intelligence scale at time 2. As can be seen in Figure 1, the partial correlation for crystallized intelligence at time 1 predicting overall engagement at time 2, while controlling for overall engagement at time 1 was not significant. In addition, the hypothesis that overall engagement in lifestyle at time 1 would predict crystallized intelligence at time 2 was not significant when we controlled for overall engagement at time 2.
Figure 2. The crystal intelligence structural model for correlations (cross-lagged); $N = 235; * p < .05; ** p < .01.$
Hypothesis 3

The hypothesis that engagement factors in lifestyle at time 1 would predict fluid intelligence at time 2 was analyzed through a Pearson’s Correlation matrix. The factors were Hobby, Physical Activity, Passive Information Processing, Novel Information Processing, and Self-Maintenance. As can be seen in Table 2, the Physical Activity Factor at time 1 was the only factor significantly correlated with fluid intelligence at time 2. For further explanation of these clusters, please see the appendix.

Hypothesis 4

The hypothesis that engagement factors in lifestyle at time 1 would predict crystallized intelligence at time 2 was analyzed through a Pearson’s Correlation matrix. The factors were Hobby, Physical Activity, Passive Information Processing, Novel Information Processing, and Self-Maintenance. For further explanation of these clusters, please see the appendix.

As can be seen in Table 2, Passive Information Processing and Novel Information Processing were the significant factors correlated with crystallized intelligence at time 2.

Table 2

Factors Correlations at Time 1 with Fluid and Crystallized Intelligence at Time 2

<table>
<thead>
<tr>
<th></th>
<th>Fluid</th>
<th></th>
<th></th>
<th>Crystallized</th>
<th></th>
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<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>(\alpha)</td>
<td>(r)</td>
<td>M</td>
</tr>
<tr>
<td>Physical</td>
<td>17.72</td>
<td>3.28</td>
<td>.33</td>
<td>.131*</td>
<td>17.72</td>
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<tr>
<td>Hobby</td>
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<td>.39</td>
<td>.099</td>
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<td>PIP</td>
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<td>NIP</td>
<td>77.96</td>
<td>12.04</td>
<td>.76</td>
<td>.109</td>
<td>77.96</td>
</tr>
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</table>
Hypothesis 5

The moderation analysis was conducted as defined by Frazier, Tix, and Barron (2004). A regression analysis was conducted to test the hypothesis that the interaction term of stimulation in activity, need for cognition, and openness to experience would moderate the effect that overall engagement in lifestyle score had on fluid intelligence at time 1. All variables were mean-centered prior to creating the interaction term. A separate regression analysis was conducted that matched the regression above, but the outcome variable was fluid intelligence at time 2, as opposed to fluid intelligence at time 1.

Hypothesis 5.1

For the first model in which fluid intelligence at time 1 was the outcome, the overall model was significant and explained 14% of the total variance of the model ($R^2 = .143$, Adj $R^2 = .087$, $p < .010$). As can be seen in Table 3, univariate analyses revealed that overall engagement in lifestyle and stimulation in activity were not significant predictors. Need for cognition and openness to experience were significant predictors. Importantly, the four-way interaction term was not significant ($\beta = .001$, $p = .317$).

Table 3

Results of Overall Engagement Multiple Regression Model for Fluid Intelligence at Time 1

<table>
<thead>
<tr>
<th>SM</th>
<th>37.03</th>
<th>5.64</th>
<th>.64</th>
<th>.084</th>
<th>37.03</th>
<th>5.64</th>
<th>.64</th>
<th>.102</th>
</tr>
</thead>
</table>

Note. *$p < .05$; ** $p < .01$; $df = 233$. PIP = Passive Information Processing; NIP = Novel Information Processing; SM = Self-Maintenance
### Hypothesis 5.2

For the first model in which fluid intelligence at time 2 was the outcome, the overall model was not significant and explained 8% of the total variance of the model ($R^2 = .077$, Adj $R^2 = .018$, $p = .212$). As can be seen in Table 4, univariate analyses revealed that overall engagement in lifestyle, stimulation in activity, need for cognition, and openness to experience were not significant predictors. The two-way interaction term of engagement in lifestyle and

<table>
<thead>
<tr>
<th>Predictor</th>
<th>$B$</th>
<th>SE</th>
<th>t</th>
<th>$p$</th>
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</thead>
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<td>Engagement in Lifestyle</td>
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<tr>
<td>Stimulation in Activity</td>
<td>.011</td>
<td>.063</td>
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<td>Need for Cognition</td>
<td>.109</td>
<td>.139</td>
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<td>.042*</td>
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<td>Openness to Experience</td>
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<td>.198</td>
<td>2.84</td>
<td>.005**</td>
</tr>
<tr>
<td>EL x SA</td>
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<tr>
<td>EL x NC</td>
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<td>.001</td>
<td>-1.23</td>
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<tr>
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<td>.001</td>
<td>-0.53</td>
<td>.596</td>
</tr>
<tr>
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<td>.111</td>
<td>1.34</td>
<td>.183</td>
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<tr>
<td>EL x SA x OE</td>
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<td>.001</td>
<td>-0.71</td>
<td>.477</td>
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<tr>
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<td>0.84</td>
<td>.402</td>
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<tr>
<td>EL x SA x NC x OE</td>
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<td>.086</td>
<td>1.00</td>
<td>.317</td>
</tr>
</tbody>
</table>

Note. *$p < .05$; ** $p < .01$; $df=233$. EL = Engagement in Lifestyle; SA = Stimulation in Activity; NC = Need for Cognition; OE = Openness to Experience.
stimulation in activity was a significant predictor. Importantly, the four-way interaction term was not significant ($\beta = .001, p = .688$).

Table 4

Results of Overall Engagement Multiple Regression Model for Fluid Intelligence at Time 2

<table>
<thead>
<tr>
<th></th>
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<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
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<tr>
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</tr>
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<td>Need for Cognition</td>
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<td>.840</td>
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<td>Openness to Experience</td>
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<td>EL x SA</td>
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<td>.186</td>
<td>2.49</td>
<td>.013**</td>
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</table>

Note. * $p < .05$; ** $p < .01$; $df = 233$. EL = Engagement in Lifestyle; SA = Stimulation in Activity; NC = Need for Cognition; OE = Openness to Experience.
Hypothesis 6

Hypothesis 6.1

The moderation analysis was conducted as defined by Frazier, Tix, and Barron (2004). A regression analysis was conducted to test the hypothesis that the interaction term of stimulation in activity, need for cognition, and openness to experience would moderate the effect of Hobby factor score had on fluid intelligence at time 1. All variables were mean-centered prior to creating the interaction term. Separate regression analyses were conducted that compared specified engagement factors predicting fluid intelligence at time 1 or at time 2. The overall model was significant and explained 13% of the total variance of the model ($R^2 = .127$, Adj $R^2 = .071, p < .010$). Need for cognition and openness to experience were significant predictors. As can be seen in Table 5, there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity, need for cognition, openness to experience and the Hobby factor while predicting fluid intelligence at time 1 ($\beta = .001, p = .059$).

Table 5

<table>
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<tr>
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<td>.023*</td>
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<tr>
<td>Openness to Experience</td>
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<td>.253</td>
<td>3.73</td>
<td>.001**</td>
</tr>
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<td>HB x SA</td>
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<td>.637</td>
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<td>HB x NC</td>
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<td>.001</td>
<td>.001</td>
<td>-0.37</td>
<td>.711</td>
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</table>
Hypothesis 6.2

The overall model was not significant and only explained 5% of the total variance of the model ($R^2 = .054$, Adj $R^2 < .001$, $p = .590$). The three-way interaction term of stimulation in activity, need for cognition, and openness to experience was a significant predictor. As can be seen in Table 6, there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity, need for cognition, openness to experience and the Hobby factor while predicting fluid intelligence at time 2 ($\beta = .001, p = .157$).

Table 6

*Results of Hobby Factor Multiple Regression Model for Fluid Intelligence at Time 2*

<table>
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<th>$t$</th>
<th>$p$</th>
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</thead>
<tbody>
<tr>
<td>Hobby Factor</td>
<td>.120</td>
<td>.076</td>
<td>1.03</td>
<td>.305</td>
</tr>
<tr>
<td>Stimulation in Activity</td>
<td>.006</td>
<td>.032</td>
<td>0.44</td>
<td>.661</td>
</tr>
<tr>
<td>Need for Cognition</td>
<td>.031</td>
<td>.037</td>
<td>0.52</td>
<td>.605</td>
</tr>
</tbody>
</table>

Note. *$p < .05$; **$p < .01$; $df=233$. HB = Hobby; SA = Stimulation in Activity; NC = Need for Cognition; OC = Openness to Experience.*
Openness to Experience  .123  .094  1.33  .185
HB x SA  .004  .092  1.22  .223
HB x NC  .006  .034  0.44  .657
HB x OE  .001  .001  -0.05  .963
SA x NC  .001  .001  -0.27  .788
SA x OE  .001  .001  -1.28  .201
NC x OE  .007  .054  0.76  .448
HB x SA x NC  .001  .001  -0.43  .667
HB x SA x OE  .001  .001  -0.19  .853
SA x NC x OE  .001  .165  1.98  .050*
HB x SA x NC x OE  .001  .126  1.42  .157

Note. *p < .05; **p < .01; df = 233. HB = Hobby; SA = Stimulation in Activity; NC = Need for Cognition; OC = Openness to Experience.

Hypothesis 6.3

The overall model was significant and explained 12% of the total variance of the model ($R^2 = .116$, Adj $R^2 = .059$, $p = .017$). Need for cognition and openness to experience were significant predictors. As can be seen in Table 7, there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity, need for cognition, openness to experience and the Physical Activity Factor while predicting fluid intelligence at time 1 ($\beta = .001$, $p = .486$).
Table 7

Results of Physical Activity Factor Multiple Regression Model for Fluid Intelligence at Time 1

<table>
<thead>
<tr>
<th></th>
<th>b</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Activity Factor</td>
<td>.178</td>
<td>.089</td>
<td>1.28</td>
<td>.202</td>
</tr>
<tr>
<td>Stimulation in Activity</td>
<td>.001</td>
<td>.001</td>
<td>-0.09</td>
<td>.926</td>
</tr>
<tr>
<td>Need for Cognition</td>
<td>.113</td>
<td>.145</td>
<td>2.13</td>
<td>.034*</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>.287</td>
<td>.255</td>
<td>3.75</td>
<td>.001**</td>
</tr>
<tr>
<td>PA x SA</td>
<td>.001</td>
<td>.089</td>
<td>-0.12</td>
<td>.907</td>
</tr>
<tr>
<td>PA x NC</td>
<td>.001</td>
<td>.001</td>
<td>-0.11</td>
<td>.910</td>
</tr>
<tr>
<td>PA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.60</td>
<td>.546</td>
</tr>
<tr>
<td>SA x NC</td>
<td>.001</td>
<td>.001</td>
<td>0.44</td>
<td>.657</td>
</tr>
<tr>
<td>SA x OE</td>
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<td>.001</td>
<td>-1.18</td>
<td>.240</td>
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<tr>
<td>NC x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.21</td>
<td>.835</td>
</tr>
<tr>
<td>PA x SA x NC</td>
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<td>.103</td>
<td>1.41</td>
<td>.161</td>
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<tr>
<td>PA x SA x OE</td>
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<td>.010</td>
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<td>.888</td>
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<tr>
<td>SA x NC x OE</td>
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<td>.082</td>
<td>1.14</td>
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<tr>
<td>PA x SA x NC x OE</td>
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<td>.001</td>
<td>-0.70</td>
<td>.486</td>
</tr>
</tbody>
</table>

Note. *p < .05; **p < .01; df=233. PA = Physical Activity; SA = Stimulation in Activity; NC = Need for Cognition; OE = Openness to Experience.

Hypothesis 6.4

The overall model was not significant and only explained 5% of the total variance of the model ($R^2 = .049$, Adj $R^2 < .001$, $p = .684$). As can be seen in Table 8, there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity,
need for cognition, openness to experience and the Physical Activity Factor while predicting fluid intelligence at time 2 ($\beta = .001, p = .785$).

Table 8

*Results of Physical Activity Factor Multiple Regression Model for Fluid Intelligence at Time 2*

<table>
<thead>
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<th>$b$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Activity Factor</td>
<td>.271</td>
<td>.127</td>
<td>1.76</td>
<td>.079</td>
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<tr>
<td>Stimulation in Activity</td>
<td>.002</td>
<td>.008</td>
<td>0.11</td>
<td>.910</td>
</tr>
<tr>
<td>Need for Cognition</td>
<td>.010</td>
<td>.012</td>
<td>0.17</td>
<td>.868</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>.099</td>
<td>.083</td>
<td>1.17</td>
<td>.242</td>
</tr>
<tr>
<td>PA x SA</td>
<td>.001</td>
<td>.008</td>
<td>0.11</td>
<td>.909</td>
</tr>
<tr>
<td>PA x NC</td>
<td>.001</td>
<td>.001</td>
<td>-0.04</td>
<td>.968</td>
</tr>
<tr>
<td>PA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.85</td>
<td>.398</td>
</tr>
<tr>
<td>SA x NC</td>
<td>.001</td>
<td>.010</td>
<td>0.13</td>
<td>.894</td>
</tr>
<tr>
<td>SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-1.08</td>
<td>.279</td>
</tr>
<tr>
<td>NC x OE</td>
<td>.007</td>
<td>.054</td>
<td>0.75</td>
<td>.453</td>
</tr>
<tr>
<td>PA x SA x NC</td>
<td>.001</td>
<td>.059</td>
<td>0.77</td>
<td>.441</td>
</tr>
<tr>
<td>PA x SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.18</td>
<td>.858</td>
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<tr>
<td>SA x NC x OE</td>
<td>.001</td>
<td>.095</td>
<td>1.27</td>
<td>.204</td>
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<tr>
<td>PA x SA x NC x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.27</td>
<td>.785</td>
</tr>
</tbody>
</table>

Note. *$p < .05$; **$p < .01$; df = 233. PA = Physical Activity; SA = Stimulation in Activity; NC = Need for Cognition; OC = Openness to Experience.*
Hypothesis 6.5

The overall model was significant and explained 14% of the total variance of the model ($R^2 = .140$, Adj $R^2 = .085$, $p = .002$). Need for cognition and openness to experience were significant predictors. The three-way interaction term of Passive Information Processing Factor, stimulation in activity, and need for cognition was a significant predictor. As can be seen in Table 9, there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity, need for cognition, openness to experience and the Passive Information Processing Factor while predicting fluid intelligence at time 1 ($\beta = .001$, $p = .394$).

Table 9

Results of Passive Information Processing Factor Multiple Regression Model for Fluid Intelligence at Time 1

<table>
<thead>
<tr>
<th></th>
<th>$b$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
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</thead>
<tbody>
<tr>
<td>Passive Information Factor</td>
<td>.069</td>
<td>.071</td>
<td>1.02</td>
<td>.307</td>
</tr>
<tr>
<td>Stimulation in Activity</td>
<td>.012</td>
<td>.066</td>
<td>0.90</td>
<td>.369</td>
</tr>
<tr>
<td>Need for Cognition</td>
<td>.104</td>
<td>.134</td>
<td>1.98</td>
<td>.049*</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>.263</td>
<td>.235</td>
<td>3.49</td>
<td>.001**</td>
</tr>
<tr>
<td>PIP x SA</td>
<td>.003</td>
<td>.112</td>
<td>1.38</td>
<td>.168</td>
</tr>
<tr>
<td>PIP x NC</td>
<td>.003</td>
<td>.021</td>
<td>0.29</td>
<td>.774</td>
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<tr>
<td>PIP x OE</td>
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</tr>
<tr>
<td>SA x NC</td>
<td>.001</td>
<td>.080</td>
<td>1.06</td>
<td>.291</td>
</tr>
<tr>
<td>SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-1.53</td>
<td>.129</td>
</tr>
</tbody>
</table>
The overall model was not significant and only explained 8% of the total variance of the model ($R^2 = .082$, Adj $R^2 = .022$, $p = .167$). The two-way interaction term of Passive Information Processing Factor and stimulation in activity was a significant predictor. The three-way interaction term of Passive Information Processing Factor, stimulation in activity, and need for cognition was a significant predictor. As can be seen in Table 10, there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity, need for cognition, openness to experience and the Passive Information Processing Factor while predicting fluid intelligence at time 2 ($\beta = .001$, $p = .215$).

**Table 10**

*Results of Passive Information Processing Factor Multiple Regression Model for Fluid Intelligence at Time 2*

<table>
<thead>
<tr>
<th></th>
<th>$b$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
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<tr>
<td>Passive Information Factor</td>
<td>.104</td>
<td>.100</td>
<td>1.39</td>
<td>.167</td>
</tr>
<tr>
<td>Stimulation in Activity</td>
<td>.013</td>
<td>.071</td>
<td>0.93</td>
<td>.352</td>
</tr>
</tbody>
</table>
Need for Cognition  .018  .021  0.30  .764
Openness to Experience  .086  .071  1.03  .305
PIP x SA  .005  .185  2.21  .028*
PIP x NC  .001  .001  -0.48  .635
PIP x OE  .001  .001  -1.03  .304
SA x NC  .002  .106  1.37  .173
SA x OE  .001  .001  -1.71  .089
NC x OE  .006  .045  0.65  .518
PIP x SA x NC  .001  .178  2.06  .041*
PIP x SA x OE  .001  .001  -0.85  .396
SA x NC x OE  .001  .099  1.37  .173
PIP x SA x NC x OE  .001  .001  -1.25  .215

Note. *p < .05; **p < .01; df = 233. PIP = Passive Information Processing; SA = Stimulation in Activity; NC = Need for Cognition; OE = Openness to Experience.

Hypothesis 6.7

The overall model was significant and explained 14% of the total variance of the model ($R^2 = .141$, Adj $R^2 = .086$, $p = .002$). Openness to experience was a significant predictor. As can be seen in Table 11, there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity, need for cognition, openness to experience and the Novel Information Processing Factor while predicting fluid intelligence at time 1 ($\beta = .001$, $p = .334$).
Table 11
Results of Novel Information Processing Factor Multiple Regression Model for Fluid Intelligence at Time 1

<table>
<thead>
<tr>
<th></th>
<th>b</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
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<td>.066</td>
<td>.120</td>
<td>1.68</td>
<td>.094</td>
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<tr>
<td>Stimulation in Activity</td>
<td>.010</td>
<td>.057</td>
<td>0.81</td>
<td>.420</td>
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<tr>
<td>Need for Cognition</td>
<td>.101</td>
<td>.129</td>
<td>1.87</td>
<td>.063</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>.221</td>
<td>.198</td>
<td>2.84</td>
<td>.005**</td>
</tr>
<tr>
<td>NIP x SA</td>
<td>.001</td>
<td>.038</td>
<td>0.52</td>
<td>.606</td>
</tr>
<tr>
<td>NIP x NC</td>
<td>.003</td>
<td>.045</td>
<td>0.57</td>
<td>.567</td>
</tr>
<tr>
<td>NIP x OE</td>
<td>.001</td>
<td>.001</td>
<td>-1.34</td>
<td>.182</td>
</tr>
<tr>
<td>SA x NC</td>
<td>.001</td>
<td>.017</td>
<td>0.20</td>
<td>.839</td>
</tr>
<tr>
<td>SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-1.22</td>
<td>.225</td>
</tr>
<tr>
<td>NC x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.68</td>
<td>.498</td>
</tr>
<tr>
<td>NIP x SA x NC</td>
<td>.001</td>
<td>.129</td>
<td>1.54</td>
<td>.125</td>
</tr>
<tr>
<td>NIP x SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.86</td>
<td>.390</td>
</tr>
<tr>
<td>SA x NC x OE</td>
<td>.001</td>
<td>.055</td>
<td>0.68</td>
<td>.499</td>
</tr>
<tr>
<td>NIP x SA x NC x OE</td>
<td>.001</td>
<td>.083</td>
<td>0.97</td>
<td>.334</td>
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</tbody>
</table>

Note. *p < .05; **p < .01; df=233. NIP = Novel Information Processing; SA = Stimulation in Activity; NC = Need for Cognition; OE = Openness to Experience.

Hypothesis 6.8

The overall model was not significant and only explained 6% of the total variance of the model ($R^2 = .065$, Adj $R^2 = .004$, $p = .385$). The two-way interaction term of Novel Information Processing Factor and stimulation in activity was a significant predictor. As can be seen in Table
there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity, need for cognition, openness to experience and the Novel Information Processing Factor while predicting fluid intelligence at time 2 ($\beta = .001, p = .932$).

Table 12

*Results of Novel Information Processing Factor Multiple Regression Model for Fluid Intelligence at Time 2*

<table>
<thead>
<tr>
<th></th>
<th>$b$</th>
<th>$\beta$</th>
<th>$T$</th>
<th>$p$</th>
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</thead>
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<tr>
<td>Novel Information Factor</td>
<td>.033</td>
<td>.056</td>
<td>0.75</td>
<td>.454</td>
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<tr>
<td>Stimulation in Activity</td>
<td>.007</td>
<td>.037</td>
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<tr>
<td>Need for Cognition</td>
<td>.004</td>
<td>.004</td>
<td>0.06</td>
<td>.951</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>.061</td>
<td>.051</td>
<td>0.70</td>
<td>.486</td>
</tr>
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<td>NIP x SA</td>
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<td>.189</td>
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<td>.030</td>
<td>0.36</td>
<td>.719</td>
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<tr>
<td>NIP x OE</td>
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<td>.001</td>
<td>-0.22</td>
<td>.825</td>
</tr>
<tr>
<td>SA x NC</td>
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<td>.058</td>
<td>0.65</td>
<td>.513</td>
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<tr>
<td>SA x OE</td>
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<td>.001</td>
<td>-1.26</td>
<td>.209</td>
</tr>
<tr>
<td>NC x OE</td>
<td>.002</td>
<td>.017</td>
<td>0.21</td>
<td>.836</td>
</tr>
<tr>
<td>NIP x SA x NC</td>
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<td>.119</td>
<td>1.36</td>
<td>.177</td>
</tr>
<tr>
<td>NIP x SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.60</td>
<td>.549</td>
</tr>
<tr>
<td>SA x NC x OE</td>
<td>.001</td>
<td>.088</td>
<td>1.04</td>
<td>.300</td>
</tr>
<tr>
<td>NIP x SA x NC x OE</td>
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<td>.008</td>
<td>0.09</td>
<td>.932</td>
</tr>
</tbody>
</table>

Note. *$p < .05$; **$p < .01$; $df = 233$. NIP = Novel Information Processing; SA = Stimulation in Activity; NC = Need for Cognition; OE = Openness to Experience.
Hypothesis 6.9

The overall model was significant and explained 13% of the total variance of the model ($R^2 = .132$, Adj $R^2 = .076$, $p = .005$). Openness to experience was a significant predictor.

As can be seen in Table 13, there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity, need for cognition, openness to experience and the Self-Maintenance Factor while predicting fluid intelligence at time 1 ($\beta = .001$, $p = .138$).

Table 13

Results of Self-Maintenance Factor Multiple Regression Model for Fluid Intelligence at Time 1

<table>
<thead>
<tr>
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<th>$b$</th>
<th>$\beta$</th>
<th>$T$</th>
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</thead>
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<tr>
<td>Self-Maintenance Factor</td>
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<td>.352</td>
</tr>
<tr>
<td>Stimulation in Activity</td>
<td>.007</td>
<td>.040</td>
<td>0.53</td>
<td>.594</td>
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<tr>
<td>Need for Cognition</td>
<td>.107</td>
<td>.137</td>
<td>1.95</td>
<td>.053</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>.248</td>
<td>.222</td>
<td>3.16</td>
<td>.002**</td>
</tr>
<tr>
<td>SM x SA</td>
<td>.003</td>
<td>.080</td>
<td>1.10</td>
<td>.272</td>
</tr>
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<td>.001</td>
<td>.001</td>
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<td>.748</td>
</tr>
<tr>
<td>SM x OE</td>
<td>.007</td>
<td>.031</td>
<td>0.44</td>
<td>.661</td>
</tr>
<tr>
<td>SA x NC</td>
<td>.001</td>
<td>.023</td>
<td>0.32</td>
<td>.746</td>
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<tr>
<td>SA x OE</td>
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<td>.001</td>
<td>-0.67</td>
<td>.507</td>
</tr>
<tr>
<td>NC x OE</td>
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<td>.025</td>
<td>0.34</td>
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<tr>
<td>SM x SA x NC</td>
<td>.001</td>
<td>.109</td>
<td>1.54</td>
<td>.125</td>
</tr>
<tr>
<td>SM x SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.78</td>
<td>.437</td>
</tr>
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</table>
Hypothesis 6.10

The overall model was not significant and only explained 8% of the total variance of the model \( R^2 = .082 \), \( \text{Adj } R^2 = .022 \), \( p = .171 \). The two-way interaction term of Self-Maintenance Factor and stimulation in activity was a significant predictor. As can be seen in Table 14, there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity, need for cognition, openness to experience and the Self-Maintenance Factor while predicting fluid intelligence at time 2 (\( \beta = .001, p = .255 \)).

<table>
<thead>
<tr>
<th>Interaction</th>
<th>( b )</th>
<th>( \beta )</th>
<th>( T )</th>
<th>( p )</th>
</tr>
</thead>
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<tr>
<td>Self-Maintenance Factor</td>
<td>.033</td>
<td>.027</td>
<td>0.35</td>
<td>.725</td>
</tr>
<tr>
<td>Stimulation in Activity</td>
<td>.008</td>
<td>.045</td>
<td>0.58</td>
<td>.563</td>
</tr>
<tr>
<td>Need for Cognition</td>
<td>.001</td>
<td>.001</td>
<td>-0.06</td>
<td>.955</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>.101</td>
<td>.085</td>
<td>1.17</td>
<td>.242</td>
</tr>
<tr>
<td>SM x SA</td>
<td>.006</td>
<td>.160</td>
<td>2.13</td>
<td>.034*</td>
</tr>
<tr>
<td>SM x NC</td>
<td>.001</td>
<td>.001</td>
<td>-1.20</td>
<td>.231</td>
</tr>
<tr>
<td>SM x OE</td>
<td>.018</td>
<td>.076</td>
<td>1.04</td>
<td>.299</td>
</tr>
<tr>
<td>SA x NC</td>
<td>.001</td>
<td>.030</td>
<td>0.41</td>
<td>.681</td>
</tr>
<tr>
<td>SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.76</td>
<td>.449</td>
</tr>
</tbody>
</table>

Note. *\( p < .05 \); ** \( p < .01 \); \( df = 233 \). SM = Self-Maintenance; SA = Stimulation in Activity; NC = Need for Cognition; OE = Openness to Experience.
Hypothesis 7

The moderation analysis was conducted as defined by Frazier, Tix, and Barron (2004). A regression analysis was conducted to test the hypothesis that the interaction term of stimulation in activity, need for cognition, and openness to experience would moderate the effect that overall engagement in lifestyle score had on Crystallized intelligence at time 1. All variables were mean-centered prior to creating the interaction term. A separate regression analysis was conducted that matched the regression above, but the outcome variable was Crystallized intelligence at time 2, as opposed to Crystallized intelligence at time 1.

Hypothesis 7.1

For the first model in which Crystallized intelligence at time 1 was the outcome, The overall model was not significant and explained 9% of the total variance of the model ($R^2 = .091$, Adj $R^2 = .032$, $p = .096$). Openness to experience was a significant predictor. As can be seen in Table 15, univariate analyses revealed that overall engagement in lifestyle, stimulation in activity and need for cognition were not significant predictors. Importantly, the four-way interaction term was not significant.

<table>
<thead>
<tr>
<th>Interaction</th>
<th>$b$ 1</th>
<th>$b$ 2</th>
<th>$b$ 3</th>
<th>$b$ 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC x OE</td>
<td>.015</td>
<td>.115</td>
<td>1.52</td>
<td>.130</td>
</tr>
<tr>
<td>SM x SA x NC</td>
<td>.001</td>
<td>.109</td>
<td>1.49</td>
<td>.137</td>
</tr>
<tr>
<td>SM x SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-1.05</td>
<td>.295</td>
</tr>
<tr>
<td>SA x NC x OE</td>
<td>.001</td>
<td>.049</td>
<td>0.66</td>
<td>.512</td>
</tr>
<tr>
<td>SM x SA x NC x OE</td>
<td>.001</td>
<td>.112</td>
<td>1.14</td>
<td>.255</td>
</tr>
</tbody>
</table>

Note. *$p < .05$; **$p < .01$; $df$ = 233. SM = Self-Maintenance; SA = Stimulation in Activity; NC = Need for Cognition; OE = Openness to Experience.
Table 15

*Results of Overall Engagement Multiple Regression Model for Crystallized Intelligence at Time 1*

<table>
<thead>
<tr>
<th></th>
<th>$b$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engagement in Lifestyle</td>
<td>.017</td>
<td>.110</td>
<td>1.49</td>
<td>.137</td>
</tr>
<tr>
<td>Stimulation in Activity</td>
<td>.004</td>
<td>.044</td>
<td>0.59</td>
<td>.557</td>
</tr>
<tr>
<td>Need for Cognition</td>
<td>.003</td>
<td>.008</td>
<td>0.11</td>
<td>.913</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>.139</td>
<td>.217</td>
<td>3.02</td>
<td>.003*</td>
</tr>
<tr>
<td>EL x SA</td>
<td>.001</td>
<td>.001</td>
<td>-0.40</td>
<td>.689</td>
</tr>
<tr>
<td>EL x NC</td>
<td>.001</td>
<td>.001</td>
<td>-0.76</td>
<td>.448</td>
</tr>
<tr>
<td>EL x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.28</td>
<td>.782</td>
</tr>
<tr>
<td>SA x NC</td>
<td>.001</td>
<td>.109</td>
<td>1.22</td>
<td>.222</td>
</tr>
<tr>
<td>SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.66</td>
<td>.509</td>
</tr>
<tr>
<td>NC x OE</td>
<td>.005</td>
<td>.076</td>
<td>0.99</td>
<td>.323</td>
</tr>
<tr>
<td>EL x SA x NC</td>
<td>.001</td>
<td>.084</td>
<td>0.98</td>
<td>.327</td>
</tr>
<tr>
<td>EL x SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.13</td>
<td>.900</td>
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<tr>
<td>SA x NC x OE</td>
<td>.001</td>
<td>.022</td>
<td>0.27</td>
<td>.784</td>
</tr>
<tr>
<td>EL x SA x NC x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.45</td>
<td>.650</td>
</tr>
</tbody>
</table>

Note. *$p < .05$; **$p < .01$; $df = 233$. EL = Engagement in Lifestyle; SA = Stimulation in Activity; NC = Need for Cognition; OE = Openness to Experience.*

**Hypothesis 7.2**

For the first model in which Crystallized intelligence at time 2 was the outcome, the overall model was significant and explained 11% of the total variance of the model ($R^2 = .109$, $\text{Adj } R^2 = .052$, $p = .028$). As can be seen in Table 16, univariate analyses revealed that overall
engagement in lifestyle, stimulation in activity, need for cognition, and openness to experience were not significant predictors. Importantly, the four-way interaction term was not significant either.

Table 16

Results of Overall Engagement Multiple Regression Model for Crystallized Intelligence at Time 2

<table>
<thead>
<tr>
<th></th>
<th>( b )</th>
<th>( \beta )</th>
<th>( t )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engagement in Lifestyle</td>
<td>.026</td>
<td>.151</td>
<td>2.07</td>
<td>.040</td>
</tr>
<tr>
<td>Stimulation in Activity</td>
<td>.001</td>
<td>.001</td>
<td>-0.09</td>
<td>.929</td>
</tr>
<tr>
<td>Need for Cognition</td>
<td>.040</td>
<td>.079</td>
<td>1.15</td>
<td>.253</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>.079</td>
<td>.110</td>
<td>1.54</td>
<td>.124</td>
</tr>
<tr>
<td>EL x SA</td>
<td>.001</td>
<td>.120</td>
<td>1.63</td>
<td>.104</td>
</tr>
<tr>
<td>EL x NC</td>
<td>.001</td>
<td>.001</td>
<td>-1.65</td>
<td>.101</td>
</tr>
<tr>
<td>EL x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.35</td>
<td>.728</td>
</tr>
<tr>
<td>SA x NC</td>
<td>.003</td>
<td>.248</td>
<td>2.82</td>
<td>.005**</td>
</tr>
<tr>
<td>SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-1.90</td>
<td>.058</td>
</tr>
<tr>
<td>NC x OE</td>
<td>.008</td>
<td>.098</td>
<td>1.29</td>
<td>.197</td>
</tr>
<tr>
<td>EL x SA x NC</td>
<td>.001</td>
<td>.155</td>
<td>1.83</td>
<td>.069</td>
</tr>
<tr>
<td>EL x SA x OE</td>
<td>.001</td>
<td>.032</td>
<td>0.45</td>
<td>.651</td>
</tr>
<tr>
<td>SA x NC x OE</td>
<td>.001</td>
<td>.151</td>
<td>-0.82</td>
<td>.415</td>
</tr>
<tr>
<td>EL x SA x NC x OE</td>
<td>-.001</td>
<td>.001</td>
<td>-1.84</td>
<td>.068</td>
</tr>
</tbody>
</table>

Note. *\( p < .05 \); ** \( p < .01 \); \( df = 233 \). EL = Engagement in Lifestyle; SA = Stimulation in Activity; NC = Need for Cognition; OE = Openness to Experience.
Hypothesis 8.1

The moderation analysis was conducted as defined by Frazier, Tix, and Barron (2004). A regression analysis was conducted to test the hypothesis that the interaction term of stimulation in activity, need for cognition, and openness to experience would moderate the effect of Hobby factor score had on Crystallized intelligence at time 1. All variables were mean-centered prior to creating the interaction term. Separate regression analyses were conducted that compared specified engagement factors predicting Crystallized intelligence at time 1 or at time 2.

The overall model was not significant and explained 9% of the total variance of the model ($R^2 = .091$, Adj $R^2 = .032$, $p = .098$). Openness to experience was a significant predictor. As can be seen in Table 17, there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity, need for cognition, openness to experience and the Hobby factor while predicting Crystallized intelligence at time 1. ($\beta = .001, p = .782$).

Table 17

Results of Hobby Factor Multiple Regression Model for Crystallized Intelligence at Time 1

<table>
<thead>
<tr>
<th></th>
<th>$b$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hobby Factor</td>
<td>.001</td>
<td>.001</td>
<td>-0.48</td>
<td>.634</td>
</tr>
<tr>
<td>Stimulation in Activity</td>
<td>.004</td>
<td>.039</td>
<td>0.54</td>
<td>.591</td>
</tr>
<tr>
<td>Need for Cognition</td>
<td>.001</td>
<td>.001</td>
<td>-0.10</td>
<td>.921</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>.166</td>
<td>.258</td>
<td>3.72</td>
<td>.001**</td>
</tr>
<tr>
<td>HB x SA</td>
<td>.001</td>
<td>.043</td>
<td>0.58</td>
<td>.562</td>
</tr>
<tr>
<td>HB x NC</td>
<td>.001</td>
<td>.001</td>
<td>-0.29</td>
<td>.771</td>
</tr>
</tbody>
</table>
Hypothesis 8.2

The overall model was not significant and explained 10% of the total variance of the model ($R^2 = .098$, Adj $R^2 = .040$, $p = .060$). Openness to experience was a significant predictor. The two-way interaction term of Hobby Factor and stimulation in activity was a significant predictor. The two-way interaction term of stimulation in activity and need for cognition was a significant predictor. As can be seen in Table 18, there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity, need for cognition, openness to experience and the Hobby factor while predicting Crystallized intelligence at time 2 ($\beta = .001$, $p = .089$).
Table 18

Results of Hobby Factor Multiple Regression Model for Crystallized Intelligence at Time 2

<table>
<thead>
<tr>
<th></th>
<th>b</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hobby Factor</td>
<td>.001</td>
<td>.001</td>
<td>-0.61</td>
<td>.544</td>
</tr>
<tr>
<td>Stimulation in Activity</td>
<td>.001</td>
<td>.001</td>
<td>-0.26</td>
<td>.798</td>
</tr>
<tr>
<td>Need for Cognition</td>
<td>.025</td>
<td>.051</td>
<td>0.72</td>
<td>.470</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>.114</td>
<td>.158</td>
<td>2.28</td>
<td>.023*</td>
</tr>
<tr>
<td>HB x SA</td>
<td>.004</td>
<td>.153</td>
<td>2.07</td>
<td>.040*</td>
</tr>
<tr>
<td>HB x NC</td>
<td>.001</td>
<td>.001</td>
<td>-1.21</td>
<td>.229</td>
</tr>
<tr>
<td>HB x OE</td>
<td>.011</td>
<td>.061</td>
<td>0.89</td>
<td>.374</td>
</tr>
<tr>
<td>SA x NC</td>
<td>.002</td>
<td>.158</td>
<td>1.97</td>
<td>.050*</td>
</tr>
<tr>
<td>SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-1.35</td>
<td>.177</td>
</tr>
<tr>
<td>NC x OE</td>
<td>.005</td>
<td>.068</td>
<td>0.98</td>
<td>.328</td>
</tr>
<tr>
<td>HB x SA x NC</td>
<td>.001</td>
<td>.034</td>
<td>0.42</td>
<td>.676</td>
</tr>
<tr>
<td>HB x SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-1.46</td>
<td>.147</td>
</tr>
<tr>
<td>SA x NC x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.36</td>
<td>.718</td>
</tr>
<tr>
<td>HB x SA x NC x OE</td>
<td>.001</td>
<td>.001</td>
<td>-1.71</td>
<td>.089</td>
</tr>
</tbody>
</table>

Note. *p < .05; ** p < .01; df = 233. HB = Hobby; SA = Stimulation in Activity; NC = Need for Cognition; OE = Openness to Experience.

Hypothesis 8.3

The overall model was not significant and explained 9% of the total variance of the model ($R^2 = .089$, Adj $R^2 = .030$, $p = .107$). Openness to experience was a significant predictor.
As can be seen in Table 19, there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity, need for cognition, openness to experience and the Physical Activity Factor while predicting Crystallized intelligence at time 1 ($\beta = .001, p = .464$).

Table 19

*Results of Physical Activity Factor Multiple Regression Model for Crystallized Intelligence at Time 1*

<table>
<thead>
<tr>
<th></th>
<th>$b$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Activity Factor</td>
<td>.001</td>
<td>.001</td>
<td>-0.04</td>
<td>.971</td>
</tr>
<tr>
<td>Stimulation in Activity</td>
<td>.003</td>
<td>.029</td>
<td>0.41</td>
<td>.682</td>
</tr>
<tr>
<td>Need for Cognition</td>
<td>.001</td>
<td>.001</td>
<td>-0.03</td>
<td>.977</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>.169</td>
<td>.262</td>
<td>3.79</td>
<td>.001**</td>
</tr>
<tr>
<td>PA x SA</td>
<td>.001</td>
<td>.001</td>
<td>-0.24</td>
<td>.813</td>
</tr>
<tr>
<td>PA x NC</td>
<td>.001</td>
<td>.001</td>
<td>-1.50</td>
<td>.135</td>
</tr>
<tr>
<td>PA x OE</td>
<td>.002</td>
<td>.011</td>
<td>0.16</td>
<td>.876</td>
</tr>
<tr>
<td>SA x NC</td>
<td>.001</td>
<td>.083</td>
<td>1.17</td>
<td>.244</td>
</tr>
<tr>
<td>SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.78</td>
<td>.435</td>
</tr>
<tr>
<td>NC x OE</td>
<td>.005</td>
<td>.077</td>
<td>1.11</td>
<td>.270</td>
</tr>
<tr>
<td>PA x SA x NC</td>
<td>.001</td>
<td>.011</td>
<td>0.15</td>
<td>.878</td>
</tr>
<tr>
<td>PA x SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.26</td>
<td>.796</td>
</tr>
<tr>
<td>SA x NC x OE</td>
<td>.001</td>
<td>.070</td>
<td>0.96</td>
<td>.336</td>
</tr>
<tr>
<td>PA x SA x NC x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.73</td>
<td>.464</td>
</tr>
</tbody>
</table>
Hypothesis 8.4

The overall model was not significant and explained 9% of the total variance of the model ($R^2 = .095$, Adj $R^2 = .036$, $p = .076$). Openness to experience was a significant predictor. The two-way interaction term of Physical Activity Factor and need for cognition was a significant predictor. As can be seen in Table 20, there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity, need for cognition, openness to experience and the Physical Activity Factor while predicting Crystallized intelligence at time 2. ($\beta = .001$, $p = .605$).

Table 20

Results of Physical Activity Factor Multiple Regression Model for Crystallized Intelligence at Time 2

<table>
<thead>
<tr>
<th></th>
<th>b</th>
<th>$\beta$</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Activity Factor</td>
<td>.094</td>
<td>.073</td>
<td>1.04</td>
<td>.300</td>
</tr>
<tr>
<td>Stimulation in Activity</td>
<td>.001</td>
<td>.001</td>
<td>-0.00</td>
<td>.999</td>
</tr>
<tr>
<td>Need for Cognition</td>
<td>.029</td>
<td>.059</td>
<td>0.85</td>
<td>.395</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>.116</td>
<td>.162</td>
<td>2.34</td>
<td>.020*</td>
</tr>
<tr>
<td>PA x SA</td>
<td>.002</td>
<td>.036</td>
<td>0.50</td>
<td>.617</td>
</tr>
<tr>
<td>PA x NC</td>
<td>.001</td>
<td>.001</td>
<td>-2.18</td>
<td>.030*</td>
</tr>
<tr>
<td>PA x OE</td>
<td>.023</td>
<td>.104</td>
<td>1.49</td>
<td>.138</td>
</tr>
<tr>
<td>SA x NC</td>
<td>.001</td>
<td>.084</td>
<td>1.19</td>
<td>.237</td>
</tr>
</tbody>
</table>
SA x OE   .001   .001   -1.61   .109
NC x OE   .008   .096    1.38   .168
PA x SA x NC   .001   .103    1.39   .167
PA x SA x OE   .001   .001   -1.02   .308
SA x NC x OE   .001   .001   -0.45   .656
PA x SA x NC x OE   .001   .001   -0.52   .605

Note. *p < .05; **p < .01; df = 233. PA = Physical Activity; SA = Stimulation in Activity; NC = Need for Cognition; OC = Openness to Experience.

Hypothesis 8.5

The overall model was significant and explained 11% of the total variance of the model ($R^2 = .116$, Adj $R^2 = .059$, $p = .017$). Passive Information Factor and openness to experience were significant predictors. As can be seen in Table 21, there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity, need for cognition, openness to experience and the Passive Information Processing Factor while predicting Crystallized intelligence at time 1 ($\beta = .001$, $p = .400$).

Table 21

Results of Passive Information Processing Factor Multiple Regression Model for Crystallized Intelligence at Time 1

<table>
<thead>
<tr>
<th></th>
<th>$b$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive Information Factor</td>
<td>.108</td>
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<td>2.73</td>
<td>.007**</td>
</tr>
<tr>
<td>Stimulation in Activity</td>
<td>.004</td>
<td>.039</td>
<td>0.52</td>
<td>.602</td>
</tr>
<tr>
<td>Need for Cognition</td>
<td>.007</td>
<td>.016</td>
<td>0.23</td>
<td>.820</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.13</td>
<td>.002**</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>-----</td>
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<td>------</td>
<td>--------</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>.137</td>
<td>.213</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PIP x SA</td>
<td>.001</td>
<td>.001</td>
<td>-.20</td>
<td>.845</td>
</tr>
<tr>
<td>PIP x NC</td>
<td>.003</td>
<td>.044</td>
<td>0.59</td>
<td>.554</td>
</tr>
<tr>
<td>PIP x OE</td>
<td>.001</td>
<td>.001</td>
<td>-.38</td>
<td>.706</td>
</tr>
<tr>
<td>SA x NC</td>
<td>.001</td>
<td>.077</td>
<td>1.01</td>
<td>.316</td>
</tr>
<tr>
<td>SA x OE</td>
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<td>.001</td>
<td>-.77</td>
<td>.442</td>
</tr>
<tr>
<td>NC x OE</td>
<td>.003</td>
<td>.039</td>
<td>0.57</td>
<td>.566</td>
</tr>
<tr>
<td>PIP x SA x NC</td>
<td>.001</td>
<td>.125</td>
<td>1.47</td>
<td>.144</td>
</tr>
<tr>
<td>PIP x SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-.46</td>
<td>.645</td>
</tr>
<tr>
<td>SA x NC x OE</td>
<td>.001</td>
<td>.036</td>
<td>0.51</td>
<td>.609</td>
</tr>
<tr>
<td>PIP x SA x NC x OE</td>
<td>.001</td>
<td>.001</td>
<td>-.84</td>
<td>.400</td>
</tr>
</tbody>
</table>

Note. *p < .05; ** p < .01; df = 233. PIP = Passive Information Processing; SA = Stimulation in Activity; NC = Need for Cognition; OE = Openness to Experience.

**Hypothesis 8.6**

The overall model was significant and explained 11% of the total variance of the model ($R^2 = .114$, Adj $R^2 = .057$, $p = .020$). Passive Information Factor was a significant predictor. The two-way interaction term of stimulation in activity and need for cognition was a significant predictor. As can be seen in Table 22, there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity, need for cognition, openness to experience and the Passive Information Processing Factor while predicting Crystallized intelligence at time 2 ($\beta = .001$, $p = .199$).
Table 22

*Results of Passive Information Processing Factor Multiple Regression Model for Crystallized Intelligence at Time 2*

<table>
<thead>
<tr>
<th>Factor</th>
<th>$b$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passive Information Factor</td>
<td>.132</td>
<td>.210</td>
<td>2.97</td>
<td>.003**</td>
</tr>
<tr>
<td>Stimulation in Activity</td>
<td>.001</td>
<td>.001</td>
<td>-0.30</td>
<td>.765</td>
</tr>
<tr>
<td>Need for Cognition</td>
<td>.046</td>
<td>.091</td>
<td>1.33</td>
<td>.184</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>.080</td>
<td>.111</td>
<td>1.63</td>
<td>.104</td>
</tr>
<tr>
<td>PIP x SA</td>
<td>.002</td>
<td>.151</td>
<td>1.84</td>
<td>.066</td>
</tr>
<tr>
<td>PIP x NC</td>
<td>.001</td>
<td>.001</td>
<td>-0.14</td>
<td>.886</td>
</tr>
<tr>
<td>PIP x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.78</td>
<td>.435</td>
</tr>
<tr>
<td>SA x NC</td>
<td>.002</td>
<td>.160</td>
<td>2.09</td>
<td>.038*</td>
</tr>
<tr>
<td>SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-1.80</td>
<td>.073</td>
</tr>
<tr>
<td>NC x OE</td>
<td>.004</td>
<td>.050</td>
<td>0.74</td>
<td>.461</td>
</tr>
<tr>
<td>PIP x SA x NC</td>
<td>.001</td>
<td>.088</td>
<td>1.03</td>
<td>.304</td>
</tr>
<tr>
<td>PIP x SA x OE</td>
<td>.001</td>
<td>.065</td>
<td>0.77</td>
<td>.441</td>
</tr>
<tr>
<td>SA x NC x OE</td>
<td>.001</td>
<td>.002</td>
<td>0.03</td>
<td>.978</td>
</tr>
<tr>
<td>PIP x SA x NC x OE</td>
<td>.001</td>
<td>.001</td>
<td>-1.29</td>
<td>.199</td>
</tr>
</tbody>
</table>

Note. *$p < .05$; **$p < .01$; df = 233. PIP = Passive Information Processing; SA = Stimulation in Activity; NC = Need for Cognition; OE = Openness to Experience.*
The overall model was not significant and explained 10% of the total variance of the model ($R^2 = .098$, Adj $R^2 = .039$, $p = .064$). Openness to experience was a significant predictor. As can be seen in Table 23, there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity, need for cognition, openness to experience and the Novel Information Processing Factor while predicting Crystallized intelligence at time 1 ($\beta = .001$, $p = .800$).

Table 23

Results of Novel Information Processing Factor Multiple Regression Model for Crystallized Intelligence at Time 1

<table>
<thead>
<tr>
<th></th>
<th>$b$</th>
<th>$\beta$</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novel Information Factor</td>
<td>.033</td>
<td>.103</td>
<td>1.42</td>
<td>.159</td>
</tr>
<tr>
<td>Stimulation in Activity</td>
<td>.006</td>
<td>.054</td>
<td>0.76</td>
<td>.449</td>
</tr>
<tr>
<td>Need for Cognition</td>
<td>.001</td>
<td>.001</td>
<td>-0.12</td>
<td>.906</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>.133</td>
<td>.207</td>
<td>2.91</td>
<td>.004**</td>
</tr>
<tr>
<td>NIP x SA</td>
<td>.001</td>
<td>.007</td>
<td>0.10</td>
<td>.921</td>
</tr>
<tr>
<td>NIP x NC</td>
<td>.001</td>
<td>.001</td>
<td>-0.67</td>
<td>.504</td>
</tr>
<tr>
<td>NIP x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.70</td>
<td>.484</td>
</tr>
<tr>
<td>SA x NC</td>
<td>.001</td>
<td>.126</td>
<td>1.45</td>
<td>.149</td>
</tr>
<tr>
<td>SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.60</td>
<td>.551</td>
</tr>
<tr>
<td>NC x OE</td>
<td>.005</td>
<td>.075</td>
<td>0.93</td>
<td>.351</td>
</tr>
<tr>
<td>NIP x SA x NC</td>
<td>.001</td>
<td>.125</td>
<td>1.45</td>
<td>.150</td>
</tr>
<tr>
<td>NIP x SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.51</td>
<td>.613</td>
</tr>
</tbody>
</table>
Hypothesis 8.8

The overall model was significant and explained 10% of the total variance of the model ($R^2 = .102$, Adj $R^2 = .045$, $p = .045$). However, the model fails to be significant after corrections. The two-way interaction term of stimulation in activity and need for cognition was a significant predictor. As can be seen in Table 24, there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity, need for cognition, openness to experience and the Novel Information Processing Factor while predicting Crystallized intelligence at time 2 ($\beta = .001, p = .096$).

Table 24

Results of Novel Information Processing Factor Multiple Regression Model for Crystallized Intelligence at Time 2

<table>
<thead>
<tr>
<th></th>
<th>$b$</th>
<th>$\beta$</th>
<th>$T$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novel Information Factor</td>
<td>.044</td>
<td>.125</td>
<td>1.72</td>
<td>.087</td>
</tr>
<tr>
<td>Stimulation in Activity</td>
<td>.001</td>
<td>.001</td>
<td>-0.12</td>
<td>.906</td>
</tr>
<tr>
<td>Need for Cognition</td>
<td>.031</td>
<td>.061</td>
<td>0.86</td>
<td>.388</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>.073</td>
<td>.101</td>
<td>1.42</td>
<td>.157</td>
</tr>
<tr>
<td>NIP x SA</td>
<td>.001</td>
<td>.139</td>
<td>1.86</td>
<td>.065</td>
</tr>
<tr>
<td>NIP x NC</td>
<td>.001</td>
<td>.001</td>
<td>-0.84</td>
<td>.405</td>
</tr>
</tbody>
</table>
Hypothesis 8.9

The overall model was not significant and explained 9% of the total variance of the model ($R^2 = .087$, Adj $R^2 = .028$, $p = .126$). Openness to experience was a significant predictor.

As can be seen in Table 25, there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity, need for cognition, openness to experience and the Self-Maintenance Factor while predicting Crystallized intelligence at time 1. ($\beta = .001$, $p = .428$).

Table 25

Results of Self-Maintenance Factor Multiple Regression Model for Crystallized Intelligence at Time 1

<table>
<thead>
<tr>
<th></th>
<th>$b$</th>
<th>$\beta$</th>
<th>$T$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Maintenance Factor</td>
<td>0.015</td>
<td>0.022</td>
<td>0.29</td>
<td>0.772</td>
</tr>
<tr>
<td>Stimulation in Activity</td>
<td>0.001</td>
<td>0.015</td>
<td>0.19</td>
<td>0.849</td>
</tr>
</tbody>
</table>

Note. *$p < .05$; ** $p < .01$; $df=233$. NIP = Novel Information Processing; SA = Stimulation in Activity; NC = Need for Cognition; OE = Openness to Experience.
<table>
<thead>
<tr>
<th>Factor</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need for Cognition</td>
<td>.001</td>
<td>.001</td>
<td>-0.17</td>
<td>.867</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>.168</td>
<td>.260</td>
<td>3.62</td>
<td>.001**</td>
</tr>
<tr>
<td>SM x SA</td>
<td>.001</td>
<td>.001</td>
<td>-0.13</td>
<td>.900</td>
</tr>
<tr>
<td>SM x NC</td>
<td>.001</td>
<td>.001</td>
<td>-0.54</td>
<td>.588</td>
</tr>
<tr>
<td>SM x OE</td>
<td>.004</td>
<td>.034</td>
<td>0.47</td>
<td>.639</td>
</tr>
<tr>
<td>SA x NC</td>
<td>.001</td>
<td>.059</td>
<td>0.80</td>
<td>.422</td>
</tr>
<tr>
<td>SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.42</td>
<td>.671</td>
</tr>
<tr>
<td>NC x OE</td>
<td>.006</td>
<td>.081</td>
<td>1.07</td>
<td>.286</td>
</tr>
<tr>
<td>SM x SA x NC</td>
<td>.001</td>
<td>.014</td>
<td>0.19</td>
<td>.852</td>
</tr>
<tr>
<td>SM x SA x OE</td>
<td>.001</td>
<td>.057</td>
<td>0.75</td>
<td>.453</td>
</tr>
<tr>
<td>SA x NC x OE</td>
<td>.001</td>
<td>.064</td>
<td>0.86</td>
<td>.393</td>
</tr>
<tr>
<td>SM x SA x NC x OE</td>
<td>.001</td>
<td>.062</td>
<td>0.79</td>
<td>.428</td>
</tr>
</tbody>
</table>

Note. *p < .05; **p < .01; df =233. SM = Self-Maintenance; SA = Stimulation in Activity; NC = Need for Cognition; OE = Openness to Experience.

**Hypothesis 8.10**

The overall model was not significant and explained 8% of the total variance of the model ($R^2 = .075$, Adj $R^2 = .016$, $p = .236$). Openness to experience was a significant predictor. As can be seen in Table 26, there was not a significant proportion of the variance explained by the four-way interaction of the stimulation of activity, need for cognition, openness to experience and the Self-Maintenance Factor while predicting Crystallized intelligence at time 2 ($\beta = .001$, $p = .539$).
Table 26

*Results of Self-Maintenance Factor Multiple Regression Model for Crystallized Intelligence at Time 2*

<table>
<thead>
<tr>
<th></th>
<th>$b$</th>
<th>$\beta$</th>
<th>$T$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Maintenance Factor</td>
<td>.051</td>
<td>.068</td>
<td>0.89</td>
<td>.372</td>
</tr>
<tr>
<td>Stimulation in Activity</td>
<td>.001</td>
<td>.001</td>
<td>-0.45</td>
<td>.655</td>
</tr>
<tr>
<td>Need for Cognition</td>
<td>.035</td>
<td>.070</td>
<td>0.96</td>
<td>.339</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>.129</td>
<td>.180</td>
<td>2.49</td>
<td>.014*</td>
</tr>
<tr>
<td>SM x SA</td>
<td>.002</td>
<td>.076</td>
<td>1.01</td>
<td>.312</td>
</tr>
<tr>
<td>SM x NC</td>
<td>.001</td>
<td>.001</td>
<td>-0.19</td>
<td>.851</td>
</tr>
<tr>
<td>SM x OE</td>
<td>.001</td>
<td>.006</td>
<td>0.08</td>
<td>.936</td>
</tr>
<tr>
<td>SA x NC</td>
<td>.001</td>
<td>.099</td>
<td>1.35</td>
<td>.177</td>
</tr>
<tr>
<td>SA x OE</td>
<td>.001</td>
<td>.001</td>
<td>-1.47</td>
<td>.142</td>
</tr>
<tr>
<td>NC x OE</td>
<td>.003</td>
<td>.046</td>
<td>0.60</td>
<td>.548</td>
</tr>
<tr>
<td>SM x SA x NC</td>
<td>.001</td>
<td>.028</td>
<td>0.38</td>
<td>.706</td>
</tr>
<tr>
<td>SM x SA x OE</td>
<td>.001</td>
<td>.118</td>
<td>1.54</td>
<td>.125</td>
</tr>
<tr>
<td>SA x NC x OE</td>
<td>.001</td>
<td>.001</td>
<td>-0.02</td>
<td>.984</td>
</tr>
<tr>
<td>SM x SA x NC x OE</td>
<td>.001</td>
<td>.048</td>
<td>0.62</td>
<td>.539</td>
</tr>
</tbody>
</table>

Note. *$p < .05$; **$p < .01$; $df=233$. SM = Self-Maintenance; SA = Stimulation in Activity; NC = Need for Cognition; OE = Openness to Experience.*
The purpose of the current study was to investigate the relationships between engagement in lifestyle, stimulation of activity, need for cognition, openness to experience, and cognitive functioning. Previous research has provided inconsistent results regarding the directional relationship of engagement in lifestyle and cognitive functioning. The current study proposed that engagement in lifestyle would predict cognitive functioning.

Overall Findings

Direct relationships. Our first two hypotheses were that engagement in lifestyle at time 1 will predict fluid intelligence (hypothesis 1) and crystallized intelligence (hypothesis 2) at time 2. Results from the current study supported these hypotheses. Bivariate correlations revealed that engagement in lifestyle at time 1 was significantly correlated with fluid and crystallized intelligence at time 2. These correlations suggest that individuals who are more active throughout their lifespan maintain higher levels of functioning for fluid and crystallized intelligence.

Longitudinal relationships. Although the bivariate correlations between engagement in lifestyle and cognitive functioning (fluid and crystallized intelligence) were significant, we next used a cross-lagged panel design to examine these relationships, in which cognitive functioning at time 1 is controlled for. However, cross-lagged results failed to identify a longitudinal relationship between engagement in lifestyle at time 1 and cognitive functioning at time 2. This finding further underlines the correlational, rather than causal, relationship among the proposed variables. Although the direct bivariate correlations were significant, there small correlation coefficients may have led to the difficulty of identifying a significant longitudinal relationship across time 1 and time 2. The results of our cross-lagged correlational analysis failed to support the well-established (Einstein & McDaniel, 2004; Hertzog, Kramer, Wilson, & Lindenberger,
2009; Stine-Morrow, 2007) “Use or Lose It” hypothesis. There are several possible reasons for our failure to find supportive of this hypothesis. Some of those reasons may be measurement error, sampling error, data entry/cleaning error, and/or missing data (some individuals failed to complete entire scales).

**Factors of engagement relationships.** We next examined the proposed five factors that comprise engagement in lifestyle – Physical Activity, Hobby, Novel Information Processing, Passive Information Processing, and Self-Maintenance. Our results failed to find support for these five factors. The internal reliability for each factor was poor, ranging from .33 - .76. Despite the poor reliability numbers, we examined hypotheses 3 and 4 that factors of engagement in lifestyle would predict cognitive functioning. Results from the current study provided mixed findings. Physical Activity Factor was the only factor significantly correlated with fluid intelligence at time 2; whereas Passive Information Processing and Novel Information Processing were the only significant factors correlated with crystallized intelligence at time 2. However, these relationships would fail to remain significant if any Bonferroni corrections were made. Given that the internal reliabilities for each of the five factors of engagement in lifestyle were poor, any results involving these five factors are questionable.

**Moderation of relationships.** Finally, it was proposed that stimulation of activity, need for cognition, and openness to experience would have a moderating relationship between engagement in lifestyle and cognitive functioning. Unfortunately, there was no little support for these proposed models of moderation. None of the 24 proposed models of moderation consisting of the four-way interaction term were significant.

Although the interaction terms failed to significantly predict cognitive functioning, there was a clear pattern in which Openness to experience was significantly related to all six models.
predicting crystallized intelligence at time 1 and three of the six models predicting crystallized intelligence at time 2. This pattern of findings suggests individuals with higher openness to experience scores have a tendency to evidence higher levels of crystallized intelligence. In addition, need for cognition and openness to experience were found to be significant contributors to models that were predicting fluid intelligence at time 1. However, those variables were not found to be significant in any models predicting fluid intelligence at time 2. We believe the participants need for cognition was better assessed through the fluid intelligence scale due to its heavy reliance on inductive and deductive reasoning. An individual that has a high need of cognition would seek out tasks are were challenging and thought provoking (i.e. solving puzzles and problems).

Limitations and Future Directions

*Measures.* The overall engagement composite scale of 81 items was found to be highly reliable for time 1 ($\alpha = .85$) and time 2 ($\alpha = .87$). However, as seen in Table 2, the subscales that made up the factors of engagement were not found to be nearly as reliable. Novel Information Processing Factor being the highest ($\alpha = .76$) and Physical Activity Factor being the lowest ($\alpha = .33$). The Physical Activity Factor’s low alpha may be due to factor only consisting of 7 items. Intelligence was measured by a non-standardized method. The measure of intelligence was a self-report measure. Participants completed this measure in their home, without the presence of an experimenter. This methodology results in participants completing the intelligence task in an uncontrolled environment. Furthermore, participants could have solicited assistance in filling out their survey. Ideally, the measures would have been collected in a standardized controlled
environment that is suitable for a formal test of intelligence like the Wechsler Adult Intelligence Scale.

*Sample.* The majority of the data were collected at long-term elderly care facilities or the individual’s home through postal services. This methodology could have provided a sampling bias that is not representative of the general population. For example, the participant pool was 76% female ($N = 179$). The sample size was relatively small, given the number of analyses that were conducted, thus our ability to detect small effect sizes was limited. Effect sizes for interactional terms tend to be very small. Therefore, our sample size ($N = 235$) had insufficient power to detect smaller effects. We were looking for four-way, which tend to be $< F^2 = .01$ or less; we had statistical power to detect $F^2 .05$ or larger. The original Time 1 participants of 619 would have provided sufficient power for data analysis. The desired population for this study has historically been a hard population to target for data collection. Participants had 18 to 24 months between time 1 and 2 data collection. Ideally, the data collections would have allowed for a longer period time between participation. Naturally, this longitudinal data collection had some attrition between time 1 and time 2. Only 42% of participants who completed time 1 also completed time 2. The fact that the sample population was elderly adults likely contributed to the higher attrition rate. Individuals who participated in time 2 data collection could have also provided some form of self-selection bias. About half of participants at time 1 indicated that they desired to be included in further data collections. For the purpose of this study, only participants that completed data collection at time 1 and 2 were used for analysis.

*Design.* The majority of past research that has been conducted on engagement in activities and cognitive functioning has been cross-sectional in nature. This research design has greatly limited our ability to detect causal relationships between these variables, and the direction
of any such causal relations. In the current study, we employed a cross-lagged panel design, which allowed us to examine potential causal relations between these variables. Although some of our bivariate correlations were significant, any time we examined these relations using the cross-lagged panel design, none of the relations were significant.

Demographic variables were used solely for descriptive statistics within this current study. Those variables were not used within our regression model. However, there has been previous research that has shown demographics variables (i.e. age, health, education level, income) tend to contribute significantly to variance of intelligence. 20% of the current sample reported having just a high school education. Furthermore, almost 50% reported an income of less than $35,000. Some research shows the lack of opportunities for older adults to “exercise” their intelligence in later life and the lack of these opportunities leading to faster declines in cognitive function. Our results warrant further exploration of how exactly these variables contribute to higher intelligence.

Conclusion

The current study aimed to provide greater clarification of the directional relationship between engagement in lifestyle and cognitive functioning. A positive correlational relationship was found between engagement of lifestyle at time 1 and cognitive functioning (crystallized and fluid intelligence) at time 2. However, the size of the correlations were small. Further, these relationships failed to remain significant in the cross-lagged design. This pattern of results suggests no causal relationship between engagement in activities and cognitive functioning. This finding is not consistent with the widely accepted ‘use it or lose it’ principle in which researchers assume that maintaining an active lifestyle will cause higher levels of cognitive functioning. We caution that the results of one study is not enough to confidently refute the ‘use it or lose it’
principle in this situation. Our low alphas for the hypothesized factors indicate poor reliability across our measure of engagement activities. The lack of significance for our hypotheses may be a direct result of this error. Our study had a number of limitations, which we discussed earlier. Perhaps the most significant limitation was our measurement of intelligence – a non-traditional measurement in which we used a paper-and-pencil measure in a non-controlled environment and no researcher physically present. In addition, the current study failed to find support for the moderation of engagement in lifestyle and cognitive functioning by the interactional term of stimulation in activity, need for cognition, and openness to experience. However, we had limited statistical power to detect a four-way interaction. Nevertheless, we did find results that are consistent with the theory that individuals with higher levels of openness to experiences tend to exhibit higher scores across crystallized intelligence. There was a consistent trend that higher levels of need for cognition were associated with higher levels of initial fluid intelligence. This pattern speaks specifically to individuals’ pursuit of cognitive development and be actively mentally engaged in their environments. Future research is encouraged to further explore how openness to experience influences cognitive functioning. Future studies should continue to explore the complex relationships between activity levels in older adults and subsequent cognitive functioning. Further development within this domain could lead to cognitive training that could help moderate cognitive decline in older adults.
APPENDIX

HYPOTHESESIZED FACTORS
Hobby Factor
12. Hobbies/Crafts such as building models, sewing, making jewelry, or Crocheting
14. Playing a musical instrument
17. Taking a nonacademic course at a local community college (For example, dance, pottery)
24. Volunteer work
25. Domestic travel
25. Foreign travel
54. Decorating my home
59. Scrapbooking
60. Photography
68. Making household repairs
75. Painting a picture
76. Gambling
78. Collecting stamps or coins
79. Collecting dolls or china

Physical Activity Factor
1. Household activities (laundry, vacuuming, dishes, cooking)
5. Using public transportation
7. Working out (going to the gym or going for a walk/jog)
11. Gardening
62. Doing car repairs/upkeep
67. Woodworking/ carpentry
69. Dancing

Passive Information Processing
18. Reading fiction
19. Reading technical/professional journals or magazines
20. Reading political articles/editorials in a newspaper or magazine
21. Watching educational T.V. programs such as those shown on History or Discovery Channel
22. Listening to talk radio shows such as NPR
32. Reading a road map
38. Playing games on the computer
39. Using the internet to visit educational sites such as Medline or National Geographic
44. Using the computer to send/receive mail messages
49. Listening to a sermon
50. Keeping a logbook or a diary
51. Watching the news on TV
55. Arranging flowers
56. Listening to live music
80. Going to the movies

**Self-Maintenance Factor**
3. Going to the grocery store/shopping
4. Planning doctor’s visits (making appointments)
8. Talking with friends on the phone
9. Attending social events/gathers
13. Cultural activities such as going to museums or attending music festivals
23. Religious activities such as bible study or going to church
40. Managing your prescription medications (taking pills at the right time etc...)
46. Using the computer to do online shopping
52. Visiting with friends in person
53. Attending family activities (weddings, holidays, reunions, etc...)
57. Going to concerts

**Novel Information Processing**

- **Cognitive**
  16. Taking an academic course at a local community college (i.e., math, science, literature)
  26. Learning a new language
  31. Using a rhyme to learn or remember something
  36. Learning new words to have a bigger vocabulary
  37. Helping grandchildren with homework
  41. Watching TV that challenges you (eg. Jeopardy)
  45. Using the computer to gain new knowledge
  47. Using the computer to take an online course
  71. Keeping a budget

- **Esoteric**
  15. Learning a new song to play on a musical instrument
  27. Doing crossword puzzles
  28. Playing board games such as chess, backgammon, or checkers
  29. Playing knowledge games such as Trivial Pursuit
  30. Playing card games such as bridge or poker
  42. Solving riddles
  43. Solving word problems (e.g. Sudoku, anagrams)
  58. Doing jigsaw puzzles
  73. Programming your cellphone
  74. Programming your VCR
  77. Playing Bingo

**Everyday**
6. Managing personal finances (paying bills)
10. Writing letters
33. Planning a meal based on nutritional value (e.g., counting calories, grams of fat, etc)
34. Planning shopping trips based on where the best deals are located
35. Comparing insurance policies to determine which one is best for me
61. Keep score in sports, such as golf or bowling
63. Being able to make change
64. Being able to understand your utility bill
65. Being able to do your own taxes
66. Being able to understand an insurance contract
70. Teaching others a skill
72. Understanding your bank statement
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