The Effect of Cold and Hot Executive Functions, Personality, General Intelligence and Emotional Intelligence in Transformational Leadership

Chrysovalanto Sofia Karatosidi
Panteion University of Social and Political Sciences

Dimitra Iordanoglou
Panteion University of Social and Political Sciences

This study investigates the role of hot and cold executive functions (EF) in transformational leadership, considering the mediating role of personality, general cognitive ability, and trait emotional intelligence (EI). EF plays an essential role in responding and adapting to new situations. The sample (N=316) consisted of students and leaders. Neuropsychological tests assessing specific domains of EF and questionnaires assessing personality, general cognitive ability, and trait EI were administered. The results showed that cold EF affects leadership, emphasizing the mediating role of personality. Furthermore, leaders performed better in communication skills, attention span, and working memory than students.

Keywords: leadership, cognitive neuroscience, transformational leadership

INTRODUCTION

Transformational leadership has been central to effective leadership behavior research for over two decades (Ramchandran, 2016). Transformational leaders mobilize their people for a common good, inspire and encourage their team to be innovative and have a shared vision and values. The leadership behaviors of the transformational leader are related to a variety of important outcomes, such as job satisfaction, performance, and effectiveness (Wang et al., 2011).

As the effectiveness of transformational leadership is widely accepted, attention should be directed to those characteristics that presuppose it. A large body of literature states that personality traits are likely to be a potential antecedent of transformational leadership (Ramchandran, 2016). Personality is mainly studied with the five-factor model: extraversion, conscientiousness, neurotism, agreeableness, and openness to experiences (McCrae & Costa, 1999). Judge et al. (2002) argue that extraversion is the only predictor of leadership styles and correlates with transformational leadership. Another meta-analysis highlighted the role of extraversion in transformational leadership, arguing that it is a generalizable finding (Bono & Judge, 2004). Another difference theoretically related to effective leadership is general cognitive ability. IQ, or general cognitive ability (GCA) refers to general intelligence, i.e. the ability to effectively adapt to the environment. IQ has a relatively limited range as a predictor of success given that highly competitive environments (such as the corporate world) are full of individuals with high levels of cognitive ability. Therefore, it is assumed that factors other than GCA could determine the critical characteristics of an effective leader (Gladwell, 2008). However, other research supports that GCA is one of the most important

predictors of job performance. People with high GCA can learn more quickly what a position requires and become qualified more easily and effectively (Schmidt & Hunter, 2004). This positive relationship between GCA and work performance has been empirically confirmed by a series of meta-analyses regardless of work context (Hunter & Schmidt, 1996; Schmidt, 2002).

On the other hand, the number of studies measuring the relationship between IQ and transformational leadership is not as large as the study of the relationship between transformational leadership and personality. DeRue et al. (2011) argue that the relationship between IQ and transformational leadership is weak. Researchers argue that personality and IQ are not enough to describe the components of transformational leadership (Phipps et al. 2015). According to Gailliot (2010), while GCA is not directly linked to leadership, another cognitive construct with similar characteristics is proposed as a possible prerequisite of transformational leadership. This construct comes from the field of neuropsychology and refers to executive functions.

Executive functions (EF) involve higher cognitive functions related to logical sequencing, mental flexibility, planning, critical thinking, and decision-making. EF impacts personal and social development, including academic achievements and job success (Diamond, 2013). They engage the prefrontal cortex associated with leading complex hierarchical behaviors (Balthazard et al. 2012). EF are separable from IQ and personality (Murdock et al., 2013) and can be a component of effective leadership behavior. Domains involving EF, such as mental control and decision making appear to be related to transformational leadership as supported by descriptive measures (Balthazard et al., 2012; Hannah et al., 2013). However, the study of EF in leadership is limited (Ramchandran, 2016). Chan et al. (2021) argue that EF are critical for individuals who lead and manage others. They support that research in organizational context has not included these functions as they are confused with assessments of GCA. EF includes decision-making and problem solving under ambiguous circumstances. Individuals in managing positions work in novel or uncertain environments. They are crucial in contexts where individuals should respond effectively in time-limited situations.

Furthermore, it has been proposed to divide EF into 'cold' and 'hot' (Zelazo & Müller, 2002). Cold EF are defined as goal-directed, future-oriented functions such as planning, inhibition, flexibility, working memory, and monitoring that manifest in emotion-free conditions and controlled environments (Miyake, Freidman, Emerson, Witzki, & Howerter, 2000). On the other hand, hot EF are goal-directed, future-oriented functions that emerge in environments that elicit emotion, motivation, and a bias between immediate pleasure and long-term reward (Zelazo & Muller, 2002; Zelazo, Qu, & Müller, 2005). In our study we rely on the selection of tools based on the distinction made by Miyake (2000) who studied three specific domains of EF, shifting, inhibition and updating and concluded that all three are clearly distinct but they share some common characteristics. These three executive functioning domains have a common neuroanatomical basis in the dorsolateral prefrontal cortex (Tei et al., 2017).

Another individual difference that has been extensively studied in effective leadership behavior is emotional intelligence. According to Boyatzis (2006), EI predicts leaders' performance more than GCA. Emotion recognition and conscientiousness positively predict transformational leadership (Rubin, Munz, & Bommer, 2005). Clarke (2010) states that EI predicts transformational leadership factors after controlling for GCA and personality. It is shown that EI is a predictive factor of academic performance beyond IQ and personality (Mestre, Guil, Lopes, Salovey, & Gil-Olarte, 2006). According to Ramchandran (2016), EI was not correlated with executive functions, revealing that cognitive and EI are two distinct constructs.

Regarding the connection between EI and personality, some studies claim that no relationship is observed between the two variables (Mayer et al., 2008), while others argue that EI is related positively to extraversion, conscientiousness, and openness to experience and negatively to neuroticism (Craig et al., 2009). Ramchandran (2011) argues that the different results between EI and personality are probably due to the different nature of the instruments used to measure the above social constructs. Many researchers have highlighted the correlation between EI and the influence of team members especially when a transformational leadership style is presented (Rinfet, Laplante, Lagacé, Deschamps & Privé, 2018). Other researchers confirm the relationship between transformational leadership and EI (e.g. Lam & O'Higgins, 2012). Transformational leaders can express their emotions, even negatively, without changing the group

members' perceptions of them. The notion that effective leaders possess high levels of EI is widely proven (Connelly & Ruark, 2010). According to a systematic review by Gomez-Leal et al. (2021) EI is a major factor in effective leadership, with self-awareness, self-management and empathy as the most critical skills.

The different theoretical and practical approaches in the field of effective leadership behavior led to further separate and investigate these critical skills. One problem is that many researchers have included only specific cognitive functions in transformational leadership research. Another concern is that most research has not simultaneously studied the main individual differences, i.e. personality, GCA, EI, and EF.

Therefore, the present study aims to investigate the role of cold and hot EF in transformational leadership, taking into account the role of personality, trait EI, and GCA. Furthermore, we attempt to investigate the differences in EF between leaders and students who can become future leaders to test if there is a specific neuropsychological profile in leadership. Our goal is to integrate basic neuropsychological findings in management.

METHODOLOGY

Sample

The sample consisted of 316 participants, of which 92 were men and 224 were women. This comprised by two groups (undergraduate/postgraduate students and leaders). In the student sample (N = 221), males represented 21.7% (78.3% females) and the mean age of the participants was 22.82 years (T.A. = 3.89).

In this research, a leader is considered someone who leads a group of people (more than two people) and has experience in his/her leadership role for at least one year. The leader sample consisted of 95 participants. Men represented 46.3 % (53.9 % women) and the mean age of the participants was 40.83 years (T.A. = 8.28). Regarding their educational level, 67.4 % held a master's degree, 27.4 % held a university degree, 3 % held a doctoral degree, and 2.2 % were high school graduates.

Procedure

To test the hypotheses, cross-sectional data were collected from a sample of leaders through "virtual avalanche sampling" (Baltar & Brunet, 2012). To attract the sample, posts were conducted on social networks. Furthermore, graduate and post-graduate students who expressed interest, enrolled in the study. The main research consisted of two phases. The first phase involved completing the research instruments used to assess personality, trait emotional intelligence, transformational leadership and general cognitive ability, and the second one involved the neuropsychological assessment.

The researchers explained that participation in this study was voluntary and anonymous, and they could withdraw from the study at any time with no repercussions for them. Candidates who agreed to participate gave written consent.

Measures
Phase 1: Questionnaires

Personality was measured by 50 Big Five Factor Markers (Vakola, Tsaousis, & Georgiades, 2006; Ypofanti et al., 2015). The specific questionnaire consists of 50 items that assess personality characteristics based on the Big Five. It includes 5 domains: a) extraversion, b) emotional stability, c) openness to experience, d) agreeableness, and e) conscientiousness.

To assess Emotional Intelligence, we used Trait Emotional Intelligence Questionnaire (TEIQue v. 1.00) (Petrides, 2001). It consists of 30 items based on a seven-point Likert-type scale and measures 15 domains that fall under emotional intelligence as a trait. These areas are adaptability, assertiveness, emotional perception, emotional expression, emotion management, emotional regulation, impulsivity, relationships, self-esteem, self-motivation, social awareness, emotion management, empathy, happiness, and optimism.

Transformational Leadership was measured by the Multifactor Leadership Questionnaire (M.L.Q) – short form Avolio & Bass (2004).It consists of 21 items, the answers given on a five-point Likert scale. This questionnaire consists of three factors of leadership styles: transformational, transactional leadership and laissez faire. For our study, only transformational leadership was measured. Transformational

leadership includes four sub-factors: idealized influence, inspirational motivation, intellectual stimulation and individualized consideration.

General Cognitive Ability was measured by International Cognitive Ability Resource (ICAR) (Revelle, Dworak & Condon, 2020) and consists of 16 questions. It is free to use for research purposes. It consists of four kinds of questions: a) logical sequence b) sequence of letters and numbers c) progressive matrices d) 3-dimensional rotation.

Phase 2: Neuropsychological Assessment

Cold Executive Functions. Verbal Fluency was assessed by the Control Oral Word Association Test (COWAT) which has two subscales. (Kosmidis et al., 2004). Phonological fluency consists of three-word production tests. The examiner asks subjects to say as many words as they know from each letter and avoid repetitions, proper nouns and variations of the same word. For each letter the examinees have one minute at their disposal. Semantic fluency consists of three categories, Animals, Fruits and Objects where each participant is asked within one minute to produce as many words as they could for each category. The score for each subscale (semantic and phonological) is the sum of the correct answers of all categories.

Digit Span belongs to the working memory subscales of the WAIS-IV (Wechsler Adult Intelligence Scale). This test requires the examinee to repeat a series of numerical digits, which are increasingly longer. The examinee should repeat each sequence either from beginning to end (forward), from end to beginning (backward), or to put the numbers in order from smallest to largest (sequencing). The test is stopped after failure in both attempts of the same question.

The Stroop Color-Word Test (Zalonis et al., 2009) consists of three conditions: Words, Colors, Color-Words. It includes three tabs of 100 items each, organized in 5 columns of 20 items. The first condition is given the tab containing the words blue, green, red printed in black ink. Examinees are asked to read as many words as possible. The second condition involves sequences of meaningless letters (XXXXX) printed in red, green, and blue ink. Participants have to name the color of each sequence as fast as they can. In the third and final condition, color names printed in incompatible ink are presented; for example, the name BLUE is printed in red ink. Participants must name the ink color of each word. The examiner records the time, errors, and self-corrections of all three tasks.

Hot executive functions. Iowa Gambling Task (IGT) (Bechara et al., 1997) measures decision-making in situations of doubt and uncertainty and presents a learning factor (Mueller, 2011). In the task, the examinees are presented a screen with 4 piles of cards with different names (A, B, C and D) and each time they are asked to choose one card. They must choose a total of 100 cards. As soon as they choose a card from each pile, they are told how much money they have won or how much money they have lost. Throughout the administration of the test, the examinee sees a bar with their total earnings. The instruction is to earn as much money as possible. Performance is calculated by subtracting the sum of the risky cards from the sum of the profitable ones.

RESULTS

The analysis of this study was implemented with the statistical analysis software JASP 0.16.4.0. Regarding demographic characteristics, the differences recorded in EF and in transformational leadership according to gender and the group to which the participants belonged were examined with the Mann-Whitney criterion, while the correlations with age and years of service were examined with Spearman's Rho index. Given the skewness recorded in many of the measures, the linear correlation between EF and transformational leadership styles was estimated using Spearman's Rho correlation coefficient. The same index was used for the relationships of personality traits, general cognitive ability and trait EI, with transformational leadership. Mediation analysis was followed to further investigate the effect of EF on transformational leadership by examining personality, GCA and trait EI as mediators. The estimates were weighted for the effects of gender, age, years of service and the group to which the participants belonged. The direct and indirect effects of EF on transformational leadership were estimated. Models were created using robust standard errors, confidence intervals, and maximum likelihood estimators. Goodness-of-fit

indices were estimated and the R² index was used for the overall contribution of each model to the improvement in prediction. The significance level was set equal to 0.05 in all cases.

The results from Spearman's Rho correlation (see Table 1) showed a strong positive correlation between Trait EI and Transformational leadership (r =.556, p < 0.01). Regarding Executive Functions, Phonological Fluency (r =.495, p < 0.01) had the strongest relationship with Transformational Leadership. while Semantic Fluency (r =.157 p < 0.05) shows a weak but statistically significant positive correlation with Transformational Leadership. All five personality factors correlate significantly with Transformational leadership, with openness to experience (r =.502, p < 0.01) and extraversion (r =.368, p < 0.01) having the strongest correlations.

TABLE 1
CORRELATIONS BETWEEN EXECUTIVE FUNCTIONS, PERSONALITY, TRAIT EI AND TRANSFORMATIONAL LEADERSHIP

	Transformational Leadership
Trait EI	.556**
Phonological fluency	.495**
Semantic Fluency	.157*
Openness to experience	.502**
Extraversion	.368**
Agreeableness	.281**
Emotional stability	.217**
Conscientiousness	.261**

** p < 0.01; *p < 0.05

To extensively investigate the relationship between executive functions and transformational leadership considering personality, GCA, and trait EI, Mediation Analysis was performed. The Mediation Analysis revealed that as far as transformational leadership is concerned, only personality plays a mediating role, not GCA and trait EI. The effect of Semantic Fluency is not statistically significant after weighing for the effects of age, years of service, and gender, but the group effect (student/leader) is statistically significant (p < 0.01). The effect of the Color Word Task is not statistically significant (p < 0.01) after weighing for the effects of age, years of service, gender, and group. The effect of Digit Span Forward is not statistically significant after weighing for the effects of age, years of service, gender, and group.

In the final model that estimates direct and indirect effects simultaneously, the effect of Semantic Fluency is not statistically significant, and therefore the mediated effect of Openness to Experience rather than the direct effect prevails. The effect of Color Word Task is not statistically significant, and therefore its mediated effect of Extraversion prevails. The effect of DSF is not statistically significant, and therefore the mediated effect of Agreeableness dominates rather than direct. The final effect of EF was not statistically significant, indicating that the effect of personality was more significant. At the same time, the effect of executive functions emerges only mediated by personality.

The second hypothesis of our study claimed that leaders are expected to perform higher in areas of executive functions than students. A comparison was made between the two groups using the Mann-Whitney criterion. From Table 2, it is evident that there is a statistically significant difference of hot and cold EF depending on the group. Semantic fluency (M-W=5028, p<0.001), Phonological Fluency (M-W=4541, p=0.018), Interference (z-score) (MW=4760, p=0.003), Errors (interference) (M-W=3602, p<0.001), DS (M-W=4919, p<0.001), DSF (M-W=5328, p<0.001), DSB (M-W=5152, p<0.001) and DSS (M-W=4765, p=0.001) show a statistically significant difference, with leaders show higher scores. Significantly higher values are recorded for leaders in all cases; therefore, our hypothesis was confirmed.

TABLE 2
DIFFERENCES IN COLD AND HOT EF BETWEEN LEADERS AND STUDENTS

	Student					Leader					
	Mean	S.D.	Median	Εύρος	N	Mean	S.D.	Median	Εύρος	N	p-value
Semantic Fluency	,65	1,10	,51	5,64	94	1,31	1,27	1,21	5,93	80	**<0,001**
Phonemic Fluency	-,29	,98	-,26	4,37	94	,06	1,01	,09	5,17	80	**0,018**
Color Task (Time)	63,79	10,87	63,00	54,00	94	60,98	9,08	60,50	52,00	80	0,159
Color Word Task (Time)	48,40	7,80	48,00	46,00	94	47,33	6,12	46,50	24,00	80	0,450
Interference (Time)	-,70	1,42	-,39	8,99	94	-,07	1,41	,16	6,87	80	**0,003**
Errors (Interference)	-,18	1,53	,38	5,54	94	,01	1,24	,33	6,59	80	**<0,001**
Self-corrections (Interference)	-,02	1,28	,37	5,44	94	-,56	1,83	,52	9,57	80	0,134
Digit Span Forward	11,47	3,05	11,00	14,00	94	14,01	3,10	14,00	12,00	79	**<0,001**
Digit Span Backward	10,19	2,65	10,00	13,00	94	12,25	3,01	12,00	12,00	79	**<0,001**
Digit Span Sequencing	9,48	2,14	10,00	10,00	94	10,80	2,36	11,00	13,00	79	**0,001**
Digit Span	10,31	2,45	10,00	13,00	94	12,90	2,93	13,00	12,00	79	**<0,001**
IGT	5,53	18,13	4,00	124,00	80	8,56	23,36	5,00	128,00	78	0,558

DISCUSSION

The present study's main objective was to investigate executive functions' role in transformational leadership, considering personality, general cognitive ability and trait emotional intelligence as mediators. Cold executive functions seem to affect transformational leadership; however, the role of personality is highlighted. Trait emotional intelligence and general cognitive ability do not mediate between executive functions and transformational leadership.

Semantic Fluency affects transformational leadership when mediated by Openness to Experience. While Semantic Fluency affects Transformational Leadership when mediated by Openness to Experience, the effect of Personality is so strong that it has a direct effect concluding that the leader who is open to new experiences is the leader who possesses transformational leadership characteristics.

Respectively, Color Word Task, which assesses speed of processing visual information and selective attention, affects transformational leadership when mediated by extraversion, the effect of personality is so strong that it has a direct effect, concluding that the extrovert leader is the leader who possesses qualities of transformational leadership. Lastly, DSF which measures auditory attention span affects transformational leadership. However, when mediated by agreeableness, the effect of personality is strong that it has a direct effect, concluding that the friendly leader is the leader who affects transformational leadership. Hence, the effect of EF on transformational leadership does not emerge significant on its own. Personality traits, namely extraversion, agreeableness and openness to experience affect transformational leadership. The results align with Ramchandran (2016) who highlights that transformational leadership is

mainly predicted by Extraversion and then by Executive functions, where the relationship is marginally significant. It also reports that the GCA does not predict transformational leadership. Other researchers argue that GCA and personality (extraversion) are the main predictors of leadership and effectiveness (Bono & Judge, 2004; Judge et al., 2002; Ilies et al., 2004). Personality and all five factors appear to have multiple correlations with leadership (Bono & Judge, 2004). Judge et al. (2002) argue that extraversion is the only predictor of leadership styles and is correlated with transformational leadership. According to neuroimaging studies, extraversion activates the amygdala and the anterior cingulate cortex (Canli, 2004).

EF contribute to leadership but not decisively, arguing that other variables such as personality contribute to transformational leadership. Cognitive functions are crucial for effectiveness in organizational settings (Bosco & Allen, 2011).

Ramchandran et al. (2016) argue that transformational leadership is predicted by cognitive flexibility by taking into account the GCA and extraversion. Lubinski et al. (2001) argue that extraversion and EF have the potential to distinguish the most capable leaders. Therefore, the combination of extraversion and EF can predict distinct prosocial characteristics of transformational leadership. EF can provide additional resources to obtain perspectives and motivation to support and empower transformational leaders to be creative in finding innovative solutions toward a greater purpose (Grant & Berry 2011; Grant, 2012).

Furthermore, the hypothesis that leaders will perform better in areas of higher cognitive functions was confirmed. The two groups presented differences in most of the cold EF. Regarding hot EF, no differences were found between the two groups. Leaders showed higher performance in Semantic and Phonological Fluency, in two Stroop subscales, Interference and Errors (Interference). Finally, they demonstrated a higher performance in all subscales of Digit Span (DSF, DSB, DSS). Verbal Fluency, Digit Span, and Stroop Test all involve communication skills. Leaders therefore exhibit better communication skills than students.

The Verbal Fluency test has been used to assess verbal ability including vocabulary knowledge and the ability to retrieve verbal information (Federmeier et al., 2002; 2010), and as an executive control assessment task (Fitzpatrick et al., 2013). Regarding the Stroop test, the leaders performed better in Interference and Errors (Interference). This instrument assesses the ability to inhibit cognitive interference, which occurs when processing one feature of a stimulus affects the simultaneous processing of another feature of the same stimulus (Stroop, 1935). Beyond a spontaneous response inhibition task, other cognitive functions such as attention, processing speed, cognitive flexibility, and working memory are involved (Kane & Engle, 2003). An interesting finding between the two groups is that leaders show a faster Interference reaction time and fewer Errors (Interference) than the students even though they are older, about twenty years, implying that leaders may be a special population with higher abilities in specific cognitive functions. Differences between the two groups were also observed in the three subscales of Digit Span. This specific tool assesses auditory attention span, retention of information in short-term memory, and working memory (Aleman & Van't Wout, 2008). Forward, backward, and sequencing assess overlapping systems of serial testing and working memory, which are important cognitive processes found in a variety of everyday activities.

Beyond the contribution of the results of this study to the understanding of the role of hot and cold EF, it is important to note some further advantages in terms of methodology. One advantage is that all the main hot and cold ELs were examined. The EF were assessed through an array of neuropsychological tests, a reliable tool for measuring cognitive functions. This study has been conducted with classical neuropsychological instruments that have been clinically demonstrated to involve activation of prefrontal brain function and have been experimentally correlated with the prefrontal cortex based on lesion or imaging studies providing a sound basis for forming brain-behavior relationships. Also, the most important variables related to effective leadership, such as personality, EI, and GCA were examined simultaneously.

CONCLUSION

An organization should intervene in its organizational context in such a way that it promotes effective leadership behavior. Assessment of higher cognitive functions can be part of evaluating both leaders and

the rest of the organization's human resources for two reasons. Firstly, for leadership development purposes, through identifying strengths and areas for improvement. Leadership development programs could include neuropsychological assessment to evaluate leaders' higher cognitive functions. Also, it can be used as a tool to assess the effectiveness of the programs. Secondly, neuropsychological assessment can be applied in candidate selection and succession. Part of the initial assessment could include neuropsychological tests for assessing higher cognitive functions adapted to the cognitive requirements of the respective role for each candidate. Neuropsychological tests are a reliable indicator of prefrontal brain function, are short and are easy to administer.

Furthermore, it would be useful to apply them in academic environments that prepare future business executives such as in undergraduate business administration programs and postgraduate programs in human resource management, MBA etc. In this context, cognitive functions of future leaders could be assessed and areas for improvement could be developed. Our results show differences in cognitive functions between students and leaders, with the former showing lower performance in areas involving communication skills, attention and working memory. For this reason, specific workshops to develop these skills could be added to university curricula.

Despite the contributions mentioned above, this study has its limitations. The sample size of leaders is limited. Our study demanded a specific amount of time, which is difficult for leaders to invest. Another limitation is that self-report questionnaires were used to assess personality, leadership and trait EI may include bias in completion. This limits the validity of the measures as self-reports raise the issue of desired responses on the participant's part. The sample of students who participated in the survey came mainly from social sciences. Therefore, it is not considered representative of the population.

It would be interesting to conduct this research with more participants (leaders and students) from different organizations and university institutions. Another suggestion for future studies would be to investigate the biological predictors of leadership. Such research may involve the use of neuroimaging methods such as the use of qEEG and the use of neurofeedback in cognitive control and self-regulation among leaders (see Waldman et al., 2018). It is also proposed to use functional magnetic resonance imaging (fMRI) to assess higher cognitive functions in the sample of leaders and compare them with the corresponding activation of neural circuits in the student sample.

REFERENCES

Aleman, A., & Van't Wout, M. (2008). Repetitive transcranial magnetic stimulation over the right dorsolateral prefrontal cortex disrupts digit span task performance. *Neuropsychobiology*, *57*, 44–48. DOI: 10.1159/000129666

Avolio, B.J., & Bass, B.M. (2004). *Multifactor Leadership Questionnaire*. Sampler Set.

Baltar, F., & Brunet, I. (2012). Social research 2.0: Virtual snowball sampling method using Facebook. *Internet Research*, *22*(1), 57–74. https://doi.org/10.1108/10662241211199960

Balthazard, P.A., Waldman, D.A., Thatcher, R.D., & Hannah, S.T. (2012). Differentiating transformational and non-transformational leaders on the basis of neurological imaging. *The Leadership Quarterly*, *23*(2), 244–258. https://doi.org/10.1016/j.leaqua.2011.08.002.

Bechara, A., Damasio, H., Tranel, D., & Damasio, A.R. (1997). Deciding advantageously before knowing the advantageous strategy. *Science*, *275*, 1293–1295.

Bono, J.E., & Judge, T.A. (2004). Personality and transformational and transactional leadership: A meta-analysis. *Journal of Applied Psychology*, *89*, 901–910.

Bosco, F.A., & Allen, D.G. (2011). Executive attention as a predictor of employee performance: Reconsidering the relationship between cognitive ability and adverse impact potential. *Academy of Management Annual Meeting Proceedings*, *8*, 1–6.

Boyatzis, R.E. (2006). Using tipping points of emotional and cognitive competencies to predict the financial performance of leaders. *Psicothema*, *18*, 124–131.

Canli, T. (2004). Functional brain mapping of extraversion and neuroticism: Learning from individual differences in emotion processing. *Journal of Personality*, *72*, 1105–1132.

Chan, T., Wang, I., & Ybarra, O. (2021). Leading and managing the workplace: The role of executive functions. *Academy of Management Perspectives*, *35*(1). https://doi.org/10.5465/amp.2017.0215

Connelly, S., & Ruark, G. (2010). Leadership style and activating potential moderators of the relationships among leader emotional displays and outcomes. *The Leadership Quarterly*, *21*(5), 745–764. https://doi.org/10.1016/j.leaqua.2010.07.005

Craig, A., Tran, Y., Hermens, G., Williams, L., Kemp, A., Morris, C., & Gordon, E. (2009). Psychological and neural correlates of emotional intelligence in a large sample of adult males and females. *Personality and Individual Differences*, *46*, 111–115.

DeRue, D.S., Ashford, S.J., & Myers, C.G. (2011). Learning agility: In search of conceptual clarity and theoretical grounding. *Industrial and Organizational Psychology*, *5*, 258–279.

Diamond, A. (2013). Executive functions. *Annu. Rev. Psychol.*, *64*, 135–168.

Federmeier, K.D., Kutas, M., & Schul, R. (2010). Age-related and individual differences in the use of prediction during language comprehension. *Brain Lang.*, *115*, 149–161. doi:10.1016/j.bandl.2010.07.006

Federmeier, K.D., McLennan, D.B., De Ochoa, E., & Kutas, M. (2002). The impact of semantic memory organization and sentence context information on spoken language processing by younger and older adults: An ERP study. *Psychophysiology*, *39*, 133–146. doi: 10.1111/1469-8986.3920133

Fitzpatrick, S., Gilbert, S.J., & Serpell, L.E. (2013). Systematic review: Are overweight and obese individuals impaired on behavioural tasks of executive functioning? *Neuropsychol. Rev.*, *23*, 138–156. doi: 10.1007/s11065-013-9224-7

Gailliot, M.T. (2010). The effortful and energy-demanding nature of prosocial behavior. In M. Mikulincer, & P.R. Shaver (Eds.), *Prosocial motives, emotions, and behavior: The better angels of our nature* (pp. 169–180). Washington, DC: American Psychological Association. doi:10.1037/12061-009

Gladwell, M. (2008). Annals of Education: Most Likely to Succeed. *Reporting & Essays: The New Yorker.*

Gómez-Leal, R., Holzer, A.A., Bradley, C., Fernández-Berrocal, P., & Patti, J. (2021). The relationship between emotional intelligence and leadership in school leaders: A systematic review. *Cambridge Journal of Education*. DOI: 10.1080/0305764X.2021.1927987

Grant, A.M. (2012). Leading with meaning: Beneficiary contact, prosocial impact, and the performance effects of transformational leadership. *Academy of Management Journal*, *55*(2), 458–476.

Grant, A.M., & Berry, J.W. (2011). The necessity of others is the mother of invention: Intrinsic and prosocial motivations, perspective taking, and creativity. *Academy of Management Journal*, *54*(1), 73–96.

Hannah, S., Balthazard, P.A., Waldman, D.A., & Jennings, P.L. (2013). The psychological and neurological bases of leader self-complexity and effects on adaptive decision-making. *Journal of Applied Psychology*, *98*(3), 393–411.

Hunter, J.E., & Schmidt, F.L. (1996). Intelligence and job performance: Economic and social implications. *Psychology, Public Policy and Law*, *2*, 447–472.

Judge, T.A., Bono, J.E., Ilies, R., & Gerhardt, M. (2002). Personality and leadership: A qualitative and quantitative review. *Journal of Applied Psychology*, *87*, 765–780.

Kane, M.J., & Engle, R.W. (2003). Working-memory capacity and the control of attention: The contributions of goal neglect, response competition, and task set to Stroop interference. *J. Exp. Psychol. Gen.*, *132*, 47–70. doi: 10.1037/0096-3445.132.1.47

Kosmidis, M.H., Vlahou, C.H., Panagiotaki, P., & Kiosseoglou, G. (2004). The verbal fluency task in the Greek population: Normative data, and clustering and switching strategies. *J Int Neuropsychol Soc.*, *10*(2), 164–72. doi: 10.1017/S1355617704102014. PMID: 15012836.

Lam, C.S., & O'Higgins, E.R. (2012). Enhancing employee outcomes: The interrelated influences of managers' emotional intelligence and leadership style. *Leadership and Organization Development Journal*, *33*(2), 149–174. https://doi.org/10.1108/ 01437731211203465

Lubinski, D., Webb, R.M., Morelock, M.J., & Benbow, C.P. (2001). Top 1 in 10,000: A 10-year follow-up of the profoundly gifted. *Journal of Applied Psychology*, *86*(4), 718–729. https://doi.org/10.1037/0021-9010.86.4.718

Mayer, J.D., Salovey, P., & Caruso, D.R. (2008). *MSCEIT user's manual*. Toronto: Multi-health systems.

McCrae, R.R., & Costa, Jr., P.T. (1999). A five-factor theory of personality. *Handbook of Personality: Theory and Research*, *2*, 139–153.

Mestre, J.M., Guil, R., Lopes, P.N., Salovey, P., & Gil-Olarte, P. (2006). Emotional intelligence and social and academic adaptation to school. *Psicothema*, *18*, 112–117.

Miyake, A., Friedman, N.P., Emerson, M.J., Witzki, A.H., Howerter, A., & Wager, T.D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology*, *41*(1), 49–100. https://doi.org/10.1006/cogp.1999.0734

Mueller, S.T. (2011). *The PEBL Bechara Gambling Task (PBGT)*. Retrieved from http://pebl.sf.net/battery.html

Murdock, K.W., Oddi, K.B., & Bridgett, D.J. (2013). Cognitive correlates of personality: Links between executive functioning and the big five personality traits. *Journal of Individual Differences*, *34*(2), 97–104. doi: 10.1027/1614-0001/a000104

Petrides, K.V., & Furnham, A. (2001). Trait emotional intelligence: Psychometric investigation with reference to established trait taxonomies. *European Journal of Personality*, *15*, 425–448.

Phipps, S.T., Prieto, L.C., & Deis, M.H. (2015). The role of personality in organizational citizenship behavior: Introducing counterproductive work behavior and integrating impression management as a moderating factor. *Journal of Organizational Culture, Communications, and Conflict*, *19*(1), 176.

Ramchandran, K., Colbert, A.E., Brown, K.G., Denburg, N.L., & Tranel, D. (2016). Exploring the neuropsychological antecedents of transformational leadership: The role of executive function. *Adaptive Human Behavior and Physiology*, *2*, 325–343.

Revelle, W., Dworak, E.M., & Condon, D. (2020). Cognitive ability in everyday life: The utility of open-source measures. *Current Directions in Psychological Science*, *29*(4), 358–363. https://doi.org/10.1177/0963721420922178

Rinfet, N., Laplante, J., Lagacé, M.C., Deschamps, C., & Privé, C. (2018). Impacts of leadership styles in health and social services: A case from Quebec exploring relationships between emotional intelligence and transformational leadership. *International Journal of Healthcare Management*, *13*(Suppl 1), 329–339. https:// doi.org/10.1080/20479700.2018.1548153

Rubin, R.S., Munz, D.C., & Bommer, W.H. (2005). Leading from within: The effects of emotion recognition and personality on transformational leadership behavior. *Academy of Management Journal*, *48*, 845–858.

Schmidt, F.L. (2002). *The Role of General Cognitive Ability and Job Performance: Why There Cannot Be a Debate* (1st Ed.). Psychology Press.

Schmidt, F.L., & Hunter, J. (2004). General mental ability in the world of work: Occupational attainment and job performance. *Journal of Personality and Social Psychology*, *86*(1), 162–173. https://doi.org/10.1037/0022-3514.86.1.162

Stroop, J.R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, *18*(6), 643–662. https://doi.org/10.1037/h0054651

Tei, S., Fujino, J., Kawada, R., Jankowski, K.F., Kauppi, J.P., Van Den Bos, W., . . . Takahashi, H. (2017). Collaborative roles of temporoparietal junction and dorsolateral prefrontal cortex in different types of behavioural flexibility. *Scientific Reports*, *7*, 6415.

Vakola, M., Tsaousis, I., & Georgiades, S. (2006). *The psychometric properties of the BFFM questionnaire with a Greek sample* [Unpublished manuscript, Athens University of Economics and Business].

Waldman, D.A., Javidan, M., & Varella, P. (2018). Charismatic leadership at the strategic level: A new application of upper echelons theory. *Leadership Quarterly*, *15*, 355–80.

Wang, N.G., Oh, I.S., Courtright, S.H., & Colbert, A.E. (2011). Transformational leadership and performance across criteria and levels: A meta-analytic review of 25 years of research. *Group & Organization Management*, *36*(2), 223–270.

Wechsler, D. (2008). *Wechsler Adult Intelligence Scale--Fourth Edition (WAIS-IV) [Database record]*. APA PsychTests.

Ypofanti, M., Zisi, V., Zourbanos, N., Mouchtouri, B., Tzanne, P., Theodorakis, Y., Lyrakos, G. (2015, October 19). Psychometric Properties of the International Personality Item Pool Big-Five Personality Questionnaire for the Greek population. *Health Psychol Res.*, *3*(2), 2206. doi:10.4081/hpr.2015.2206. PMID: 26973962; PMCID: PMC4768534.

Zalonis, I., Christidi, F., Bonakis, A., Kararizou, E., Triantafyllou, N.I., Paraskevas, G., . . . Vasilopoulos, D. (2009). The stroop effect in Greek healthy population: Normative data for the Stroop Neuropsychological Screening Test. *Arch Clin Neuropsychol.*, *24*(1), 81–8. doi:10.1093/arclin/acp011

Zelazo, P.D., & Müller, U. (2002). Executive function in typical and atypical development. In U. Goswami (Ed.), *Handbook of childhood cognitive development* (pp. 445–469). Oxford: Blackwell.

Zelazo, P.D., Qu, L., & Müller, U. (2005). Hot and cool aspects of executive function: Relations in early development. In W. Schneider, R. Schumann- Hengsteler, & B. Sodian (Eds.), *Young children's cognitive development: Interrelationships among executive functioning, working memory, verbal ability, and theory of mind* (pp. 71–93). Mahwah, NJ: Lawrence Erlbaum.