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Cognitive and Social, Emotional, and Behavioral Foundations of Transformational Leadership Attitudes: Evidence from a National Sample of Brazilian Federal Public Managers

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Abstract

Transformational leadership attitudes have been widely associated with positive organizational outcomes; however, their psychological foundations remain only partially understood, particularly in public-sector contexts. This study examined the joint contributions of executive functions (EF) and social, emotional, and behavioral (SEB) skills to transformational leadership attitudes (TLA) in a national sample of Brazilian federal public managers (N = 70). EF were assessed using a digital battery of performance-based tasks, and SEB were measured using the Brazilian version of the Behavioral, Emotional, and Social Skills Inventory (BESSI-BR). TLA were assessed with a validated Brazilian leadership scale. Hierarchical regression analyses, controlling for age and education, showed that SEB, especially emotional resilience and social engagement, were strongly associated with TLA, accounting for most of the explained variance. In contrast, EF showed limited global associations, although inhibitory control was positively related to individualized consideration in exploratory analyses. These findings suggest that transformational leadership in public organizations primarily reflects SEB competencies, complemented by specific cognitive self-regulatory processes. Practical implications highlight the relevance of incorporating SEB development and targeted cognitive training into public leadership selection, assessment, and development programs, contributing to more effective people management and public service delivery, and informing leadership development practices in public organizations.

Preregistration: https://osf.io/8jz6k

Introduction

Transformational Leadership in the Public Sector

Transformational leadership has been consistently associated with positive outcomes with moderate-to-large effect sizes in organizational effectiveness, employee engagement, and psychosocial well-being, particularly in complex and high-demand contexts such as public administration (Backhaus & Vogel, 2022; Bao et al., 2025; Huang & Villadsen, 2023; Waldman & Balthazard, 2015). Leaders who articulate a compelling vision, stimulate intellectual engagement, and demonstrate individualized consideration tend to foster higher levels of motivation, trust, and adaptive performance among followers (Avolio & Bass, 2004; Bao et al., 2025; Molenberghs et al., 2017).

Recent meta-analytic evidence in the public administration domain confirmed the robustness and consistency of these associations across institutional settings and outcome domains (Bao et al., 2025). Despite this solid evidence base, the psychological mechanisms underlying individual differences in transformational leadership attitudes (TLA) remain only partially understood, particularly when cognitive and social, emotional, and behavioral processes are examined jointly (Hannah et al., 2013; Karatosidi & Iordanoglou, 2024; Lindebaum & Raftopoulou, 2017).

Cognitive and Social, Emotional, and Behavioral Foundations of Transformational Leadership

Executive Functions and Transformational Leadership

Theoretical and empirical advances suggested that leadership should be understood as a multidimensional phenomenon emerging from the interaction between higher-order cognitive control processes, such as executive functions (EF), and social, emotional, and behavioral (SEB) skills (Chan et al., 2021; Humphrey et al., 2016). EF support the regulation of goal-directed behavior, adaptive responding, and complex decision-making, all of which are critical for effective leadership in dynamic organizational environments (Chan et al., 2021; Hannah et al., 2013).

Contemporary integrative perspectives further indicate that specific EF components —particularly working memory (WM), inhibitory control (IC), and decision-making processes under uncertainty (DM) — play a central role in shaping leaders' capacity to sustain goal-directed behavior, regulate impulses, and make adaptive strategic choices in socially accountable contexts (Chan et al., 2021; Karatosidi & Iordanoglou, 2024). Although cognitive flexibility has also been linked to adaptive leadership in broader EF frameworks, emerging neuropsychological evidence suggests that leadership effectiveness is especially associated with executive control capacities related to response inhibition and risk-sensitive decision-making, which facilitate responsible action under uncertainty and the coordination of complex interpersonal demands (Ramchandran et al., 2016).

Experimental and neurocomputational findings further indicate that leadership involves a distinct form of executive decision-making in socially responsible contexts, whereby individuals differ in their willingness to assume responsibility for outcomes affecting others — a process supported by higher-order control networks and associated with leadership-related behavior (Edelson et al., 2018).

Social, Emotional, and Behavioral Skills and Transformational Leadership

In parallel, research on SEB skills has increasingly been organized around the integrative framework proposed by Soto et al. (2022), which conceptualizes these skills as functional capacities to regulate emotions, maintain social relationships, and manage goal-directed behavior in demanding contexts. Within this framework, emotional resilience (ER) and social engagement (SE) emerge as particularly relevant domains for leadership functioning. ER reflects the capacity to regulate stress and mood fluctuations, supporting adaptive responses under sustained cognitive and emotional demands. SE encompasses skills related to initiating interactions, communicating effectively, and asserting ideas within groups, facilitating trust building, information exchange, and coordinated action in team environments (Fernandes et al., 2024; Soto et al., 2022).

Leadership research further indicates that emotional processes operate across multiple levels of organizational life, shaping how leaders influence group climate, motivation, and interpersonal dynamics (Humphrey et al., 2016). Empirical findings also suggest that leaders' capacity to regulate and express emotions constructively, as well as to engage sensitively with others, is positively associated with transformational leadership behaviors (Esteves et al., 2024; Gómez-Leal et al., 2022). These socio-emotional competencies are therefore understood as behavioral facilitators of effective leadership functioning rather than as substitutes for cognitive control mechanisms. Integrative perspectives additionally suggest that such competencies operate in concert with executive control processes in contexts requiring strategic adaptation and sustained interpersonal coordination (Karatosidi & Iordanoglou, 2024; Toh & Yang, 2024).

Integrative Gaps in the Literature

Although prior studies have independently linked EF and socio-emotional competencies to leadership-related outcomes, unified analytical frameworks examining their joint and incremental contributions remain scarce (Karatosidi & Iordanoglou, 2024). Meta-analytic syntheses have further indicated that, while a wide range of antecedents of transformational leadership has been examined, comparatively few studies explicitly integrate cognitive and social, emotional, and behavioral mechanisms within a single analytical model (Bao et al., 2025). Much of the empirical literature has relied either on self-report measures of cognitive abilities or on narrow operationalizations of leadership, limiting the ability to disentangle the relative contribution of cognitive versus socio-emotional domains (Karatosidi & Iordanoglou, 2024; Lee et al., 2012; Lindebaum & Raftopoulou, 2017). Moreover, there remains a notable gap in the literature regarding leadership processes in the public sector, where decision-making constraints, bureaucratic complexity, and social accountability place distinct demands on leaders' cognitive control and emotional regulation capacities (Bao et al., 2025; Huang & Villadsen, 2023).

The Present Study

Addressing these gaps, the present study focuses on theoretically and empirically salient EF components — WM, IC, and DM — given their relevance for goal maintenance, behavioral regulation, and adaptive responding in leadership contexts. In parallel, it examines key SEB skills associated with adaptive leadership functioning, including emotional resilience (ER), social engagement (SE), cooperation (CO), self-management (SM), and empathy.

Although recent studies have sought to integrate executive functions and socio-emotional constructs in the prediction of transformational leadership (e.g., Karatosidi & Iordanoglou, 2024), such work has primarily emphasized dispositional variables such as personality and trait emotional intelligence. In contrast, the present study advances the literature by examining SEB skills conceptualized as functional competencies, assessed within a preregistered multimethod framework and in a nationally distributed sample of experienced public-sector leaders.

EF are assessed using an adapted digital battery of performance-based tasks, whereas SEB are measured through the Brazilian version of the Behavioral, Emotional, and Social Skills Inventory (BESSI-BR; Fernandes et al., 2024; Soto et al., 2022). Transformational leadership attitudes (TLA) are evaluated using a validated Brazilian scale (Fonseca & Porto, 2013). By integrating performance-based cognitive indicators and self-reported social, emotional, and behavioral skills, the study adopts a multimethod assessment strategy that broadens construct representation while minimizing reliance on a single measurement source.

Guided by a preregistered analytical plan, the study pursues two primary objectives: (a) to describe the variability and profile of selected EF components and SEB skills among federal public managers; and (b) to test a heuristic model examining their unique and joint contributions to TLA while controlling for relevant covariates. Entering EF and SEB as separate predictor blocks in hierarchical regression models allows the evaluation of their incremental explanatory power.

By integrating core executive control processes and theoretically grounded SEB skills within a preregistered and methodologically rigorous design, this study offers a preregistered multimethod test of an integrative framework linking executive control and social, emotional, and behavioral skills to leadership attitudes in the public sector.

Study Hypotheses

Consistent with the preregistered analytical plan, the present study tested the following hypotheses:

H1 (Variability Hypothesis).

Both global scores and indicator-level scores of EF components, SEB skills, and TLA will show meaningful inter-individual variability, as reflected in adequate dispersion indices and absence of substantial floor or ceiling effects within the sample. This expectation is grounded in the substantial heterogeneity of the sample with respect to age, professional background, organizational cultures, and career trajectories within the Brazilian federal public service, as well as in prior evidence indicating meaningful interindividual variability in executive decision-making, emotional regulation, and leadership-related neural and behavioral markers (Balthazard et al., 2012; Edelson et al., 2018; Fatima et al., 2020).

H2 (EF → TLA hypothesis).

Executive functions will be positively associated with transformational leadership attitudes. This hypothesis builds on both foundational and contemporary work suggesting that higher-order cognitive control processes — particularly WM, IC, and DM — support leadership-related behavior, responsibility-taking, and adaptive decision-making in complex organizational contexts (Chan et al., 2021; Edelson et al., 2018; Karatosidi & Iordanoglou, 2024; Ramchandran, 2011; Ramchandran et al., 2016, 2020). Cognitive flexibility (CF) was also examined in an exploratory manner, given its relevance in broader EF frameworks.

H3 (SEB → TLA Hypothesis).

Social, emotional, and behavioral skills will be positively associated with transformational leadership attitudes. This hypothesis builds on evidence indicating that ER, SE, and related socio-emotional competencies such as cooperation, self-management, and empathy support effective leadership functioning, including relationship building, emotional regulation, and adaptive interpersonal behavior in organizational contexts (Bergner et al., 2022; Cavaness et al., 2020; Esteves et al., 2024; Frias et al., 2021; Gómez-Leal et al., 2022; Humphrey et al., 2016; Prezerakos, 2018).

H4 (Exploratory Joint Hypothesis).

EF components and SEB skills will show joint and potentially interactive associations with transformational leadership attitudes. In particular, WM, IC, and DM are expected to relate to TLA in combination with emotional resilience, social engagement, and related socio-emotional competencies, reflecting integrative perspectives that emphasize the coordinated role of cognitive control and socio-emotional regulation in adaptive leadership functioning (Connelly & Ruark, 2010; Humphrey et al., 2016; Molenberghs et al., 2017; Toh & Yang, 2024).

Methods

Preregistration and Transparency

The study protocol, hypotheses, eligibility criteria, outcome measures, and primary statistical analysis plan were preregistered prior to data inspection on the Open Science Framework (OSF; https://osf.io/8jz6k). Any deviations from the preregistered protocol are explicitly reported in the manuscript.

Study Design

This was a cross-sectional observational study based on random sampling of Brazilian federal public managers. No blinding or experimental manipulation was implemented, and each participant contributed a single set of scores. Primary analyses included descriptive and variability analyses, partial correlations controlling for demographic covariates, and hierarchical multiple regression models with TLA as the dependent variable.

Participants and Sampling

Participants were randomly selected from the official national directory of federal management positions distributed across Brazil's 27 federative units (sampling frame = 1,100 + managers at the time of recruitment). Recruitment occurred in successive waves. After each cycle expired, individuals who had not responded were excluded from subsequent draws, and a new random selection was performed among the remaining not-yet-invited managers. Across all waves, 687 managers were invited via institutional email and official communication channels.

No financial compensation was offered; participation was voluntary and target recruitment was $N = 82$, ensuring a final analyzed sample of at least 78 participants, based on an a priori power analysis ($\alpha = .05$, $1 - \beta = .80$, $f^2 = 0.15$).

Eligibility and Cognitive Screening

Eligibility criteria included: (a) age ≥ 20 years, (b) absence of self-reported neurological or psychiatric conditions suggestive of atypical neurodevelopment, and (c) adequate global cognitive functioning. Cognitive screening was conducted via videoconference prior to enrollment and included the Mini-Mental State Examination (MMSE), the Montreal Cognitive Assessment (MoCA), and an estimate of general intellectual functioning derived from the Wechsler Adult Intelligence Scale – Third Edition (WAIS-III IQ).

The MMSE served as the sole formal inclusion criterion. A cutoff score of ≥ 24 was adopted to exclude individuals with potential global cognitive impairment, following recommendations for highly educated samples (Kochhann et al., 2010; sensitivity = 87%, specificity = 82%). The MoCA and WAIS-III IQ were administered as complementary indicators to provide broader characterization of executive, attentional, and general intellectual functioning, supporting global cognitive comparability within the sample.

MoCA performance, particularly on the MoCA-MIS, suggested that a subset of participants presented profiles consistent with possible mild cognitive impairment, despite meeting MMSE inclusion criteria. In order to ensure methodological transparency without altering predefined eligibility criteria, these findings were documented and considered in the interpretation of the cognitive screening phase.

Procedure

Data collection followed a two-day sequential online protocol hosted on a secure university server and accessed via individual participant codes:

- Day 1: Sociodemographic questionnaire (~ 5 min) and a digital battery of seven EF tests (~ 45 min).
- Day 2: BESSI-BR (~ 25 min) and a Brazilian TLA scale (~ 20 min).

Participants were instructed to complete all activities in a quiet, interruption-free environment without the presence of third parties. The estimated total duration was approximately 95 minutes.

Although a broader set of cognitive and socio-emotional indicators was collected as part of the preregistered umbrella study, the present analyses focus on theoretically selected EF components and SEB skills. The extended dataset was retained to enable sensitivity, exploratory, and subsequent multivariate analyses.

Measures

Executive Function Battery (Digital Adaptation)

All seven EF tasks were adapted from open-source paradigms available in *PsyToolkit* (Stoet, 2010, 2017) and reimplemented in *OpenSesame* (Mathôt et al., 2012) for computerized administration in Brazilian Portuguese. The adaptation followed the International Test Commission (ITC) guidelines for cross-cultural test translation and adaptation (Hambleton & Zenisky, 2011), ensuring conceptual, linguistic, and functional equivalence.

Two independent forward translations were produced and evaluated through a two-stage expert review conducted by three specialists in cognitive psychology and psychometrics. The first round focused on prototype screenshots, allowing refinement of stimuli, instructions, and interface layout. The second applied a structured checklist derived from ITC criteria. Inter-rater agreement, estimated using Fleiss' Kappa, increased from $\kappa = .59$ to $\kappa = .84$, indicating strong linguistic and cultural adequacy. Temporal parameters for each task are provided in Supplementary Material S1 and will be archived in a public open-science repository upon publication.

The digital battery assessed multiple EF domains (WM, IC, DM, and exploratory CF indicators). The present analyses focus primarily on theoretically selected components (WM, IC, and DM), whereas CF was examined in an exploratory manner. The following subsections describe the EF tasks used to measure each domain.

Working Memory

Working memory was assessed using two computerized tasks: the Digit Span task (WM storage) and the 2-back task (WM manipulation/updating).

Digit Span (WM Storage)

WM storage was assessed using a computerized Digit Span task (Wechsler, 1997). Digits were presented visually for 700 ms with a 300 ms interstimulus interval. Participants recalled sequences of 2–9 digits in the same order by selecting numbers on the screen. Two trials were administered for each sequence length.

Performance was summarized using a standardized Digit Span composite score (storage component) integrating total correct trials and maximum span length. Both indices were z-standardized and averaged so that higher scores indicate greater storage capacity. Internal consistency for Digit Span in Brazilian adult samples is high ($\alpha = 0.88$; Júlio-Costa & Haase, 2017).

N-back (2-back; WM Manipulation)

WM manipulation was assessed using a 2-back task (Hepdarcan & Can, 2025; Kane et al., 2007). Consonant letters (B, F, K, L, H, M, P, R, T, V, X, Y) were presented for 500 ms with a 2000 ms interstimulus interval. Participants indicated whether the current stimulus matched the one presented two trials earlier. The task consisted of six blocks of 36 trials with short rest intervals between blocks.

Task performance was indexed by a Nback-2back composite score (manipulation component) integrating signal-detection sensitivity (*d'*) and reaction time for correct responses. Both indicators were *z*-standardized and averaged, with reaction time reverse-scored so that higher values indicate greater updating efficiency. Reliability estimates for N-back paradigms in Brazilian adult samples typically range between α = .80–.85 (De Nardi et al., 2013).

Finally, the standardized scores from both tasks were averaged to create a WM composite score, representing overall working memory performance.

Inhibitory Control

Inhibitory control was assessed using two computerized tasks capturing complementary components of inhibition: interference suppression and response inhibition.

Stroop Test (Interference Suppression)

IC interference control was assessed using a computerized Stroop Color–Word task (MacLeod, 1991). Stimuli were presented for 1000 ms, with responses allowed up to 1500 ms and a jittered interstimulus interval (1000 ± 200 ms). Participants completed 30–40 trials per condition (congruent and incongruent).

Performance was quantified using reaction-time and accuracy interference effects, calculated as the differences between incongruent and congruent trials. These indicators were z-standardized and averaged to form a Stroop composite score, ensuring balanced integration of speed- and accuracy-based interference while avoiding distortions associated with ratio-based efficiency measures (Alfers et al., 2025). Higher values indicated more efficient inhibitory control. Previous evidence suggests adequate reliability for Stroop performance in Brazilian adult samples (α = .80–.85; Júlio-Costa & Haase, 2017; Miotto et al., 2023).

Go/NoGo (IC - Response Inhibition)

Response inhibition was assessed using a Go/No-Go task (Verbruggen et al., 2019; Verbruggen & Logan, 2008). Stimuli were presented for 300–400 ms with an 800 ms response window and a jittered interstimulus interval (1000 ± 200 ms). The task comprised 160 trials, including 20% No-Go trials.

Performance was operationalized as a standardized Go/NoGo composite score integrating signal-detection sensitivity (*d'*) and mean reaction time for correct Go trials. Both indices were z-standardized and averaged, with reaction time reverse-scored so that higher values indicate greater inhibitory efficiency. Previous evidence suggests adequate reliability for Go/NoGo performance in Brazilian samples (α = 0.76; Beato et al., 2012).

Finally, the standardized scores from both IC tasks were averaged to form an IC composite score, indexing overall inhibitory control performance.

Decision-Making

Iowa Gambling Task (DM - Decision Learning and Risk Evaluation)

DM was assessed using the Iowa Gambling Task (IGT; Bechara et al., 1994). Participants completed 100 selections from four decks with different reward–loss contingencies. Immediate feedback was provided after each choice.

Task performance was operationalized using a DM composite score integrating two indicators: the net score, calculated as the difference between advantageous and disadvantageous deck selections [(C + D) − (A + B)], reflecting overall decision quality, and a learning index representing performance improvement across the task, computed as the difference between the final and initial blocks of trials (Block 5 − Block 1).

Both indicators were z-standardized and averaged to form the DM composite score, with higher values indexing more advantageous decision-making and learning across the task. Previous evidence indicates acceptable reliability for IGT performance in Brazilian samples (α = .74; Malloy-Diniz et al., 2008).

Cognitive Flexibility

Finally, CF indicators were included as exploratory EF measures and were assessed using two computerized tasks capturing complementary aspects of flexible cognitive control: set shifting and switching efficiency.

Wisconsin Card Sorting Test (CF - Set Shifting)

Set-shifting ability was assessed using a computerized Wisconsin Card Sorting Test (WCST) based on the Brazilian manual for the 128-trial version (Mônego et al., 2019). Participants matched response cards to reference cards according to implicit rules (color, form, or number), which changed after 10 consecutive correct responses.

Task performance was derived using three indices: categories completed, perseverative errors, and failures to maintain set. A composite WCST score was computed by z-standardizing each indicator and reverse-scoring error measures before averaging so that higher scores reflect greater set-shifting efficiency. Digital WCST implementations show good psychometric properties in adult samples (Steinke et al., 2021).

Task Switching (CF – Switching Efficiency)

CF was also assessed using a task-switching paradigm (Monsell, 2003; Vandierendonck et al., 2010). Participants alternated between two classification tasks guided by visual cues, with cue–stimulus intervals ranging from 300–600 ms and response windows up to 2000 ms.

Performance was summarized using a Task Switching composite score integrating reaction-time switch cost, accuracy switch cost, and accuracy on switch trials. All indices were z-standardized and averaged, with cost measures reverse-scored so that higher values indicate greater switching efficiency. Composite scoring approaches are recommended to improve reliability in task-switching paradigms (Draheim et al., 2016; Hedge et al., 2018; Vandierendonck, 2021).

Finally, the standardized scores from both tasks were averaged to form a CF composite score, indexing overall cognitive flexibility performance.

Social, Emotional, and Behavioral Skills (SEB)

SEB were assessed using the Brazilian version of the Behavioral, Emotional, and Social Skills Inventory (BESSI-BR), a 192-item self-report instrument originally developed by Soto et al. (2022) and adapted for use in Brazil by Fernandes et al. (2024). The inventory assesses five domains of SEB — Self-Management (SM), Social Engagement (SE), Cooperation (CO), Emotional Resilience (ER), and Innovation (IS) — comprising 32 specific skill facets.

Participants rated how well they were able to enact each skill using a five-point Likert scale ranging from 1 (“not at all well”) to 5 (“extremely well”). Evidence from the Brazilian adaptation indicates high internal consistency at both the domain level (mean α = .94, range .91–.97) and the facet level (mean α = .86, range .77–.94), with comparable estimates based on McDonald’s omega (ω), supporting the robustness of the instrument’s measurement properties (Fernandes et al., 2024).

In the present study, mean scores were computed for each domain and for a global SEB skills index representing an overall indicator of SEB competence across the five domains. Consistent with the preregistered analysis plan, only Social Engagement (SE) and Emotional Resilience (ER) were included as predictors in the primary models, as these domains show the strongest conceptual links to transformational leadership and present lower conceptual overlap with executive function constructs. SE and ER scores were subsequently standardized (z-scores) to enhance comparability with other predictors in the regression models.

Transformational Leadership Attitude (TLA)

TLA were assessed using the Attitudes toward Leadership Styles scale developed by Fonseca and Porto (2013). The instrument comprises items derived from internationally validated leadership measures, including the Transformational Leadership Inventory (TLI), the Multifactor Leadership Questionnaire (MLQ), and the Leader Reward and Punishment Questionnaire (LRPQ). Factor-analytic validation identified two factors corresponding to transformational leadership (24 items) and transactional leadership (8 items), with internal consistency estimates of α = .91 and α = .74, respectively (Fonseca & Porto, 2013).

Participants rated their attitudes toward each leadership behavior using a seven-point Likert scale (1–7). For the purposes of this study, only the transformational leadership dimension was analyzed. A TLA

composite score was computed by averaging responses across the transformational leadership items. This score was subsequently standardized (*z*-score) to enhance comparability with other predictors in the regression models.

Analytic Plan

Data quality procedures were implemented to ensure valid estimation of EF performance. For computerized tasks involving RT, trials were considered valid only when a response was recorded and latency fell within a predefined temporal window (200–1500 ms). Trials with missing responses or latencies outside this range were excluded from RT-based calculations, whereas omission trials and invalid responses were treated as errors in accuracy-based indices.

Potential outliers were initially flagged using the IQR criterion applied to original score distributions and subsequently inspected on a case-by-case basis. Statistical outliers were not automatically excluded. Participant-level exclusion was considered only when there was clear evidence of invalid response processes, such as random responding, systematic non-engagement, or failure to understand task instructions. Low-performing cases were otherwise interpreted as reflecting genuine interindividual variability and were retained.

Domain-specific scoring procedures were adopted for EF components. For WM and CF indicators, score distributions were approximately normal and showed no evidence of extreme values indicative of invalid task engagement. For IC, composite indices were constructed by integrating standardized RT- and accuracy-based effects to avoid distortions associated with ratio-based efficiency measures. Participants with fewer than 35 valid Stroop trials (out of 80) were excluded from Stroop-based indices due to insufficient task engagement or unreliable performance estimates. For DM, assessed via the IGT, non-normal and asymmetric distributions were theoretically expected; extreme values were interpreted as meaningful indicators of advantageous or disadvantageous decision-making strategies rather than statistical outliers.

Hierarchical multiple regression models were used to examine EF indicators (WM, IC, and DM) and SEB skills (SE and ER) as predictors of TLA, with age and education level included as covariates. Cognitive flexibility indicators were examined only in exploratory and sensitivity models. Although additional covariates were preregistered, they were not included in the primary models due to concerns about model overfitting given the modest sample size. Age and education were entered first (Step 0), followed by EF and SEB predictor blocks in alternative orders to examine incremental validity.

Parametric statistical methods were applied to EF components showing approximate normality. For DM indicators derived from the IGT, distributional characteristics were explicitly acknowledged, and robust analyses were conducted when appropriate. Sensitivity analyses additionally examined the potential influence of sex on regression estimates. Standardized regression coefficients (β), changes in explained

variance (ΔR^2), and 95% confidence intervals were reported. To assess estimate stability, bootstrap confidence intervals based on 5,000 resamples were computed.

No data transformations beyond scale scoring and standardization were planned. Item-level mean substitution was permitted when at least 80% of a scale was completed. EF tasks not fully completed were excluded from analyses for that specific measure only. Missing data below 5%, assumed to be missing at random, were handled using listwise deletion in regression models; higher levels of missingness prompted exploratory multiple imputation procedures.

Ethical Considerations

This study was approved by the Ethics Committee of the Institute of Psychology, Universidade Federal do Rio Grande do Sul (UFRGS; Protocol 7.274.390, CAAE 84134724.5.0000.5334, December 7, 2024). All participants provided digital informed consent prior to participation, and all procedures were classified as minimal risk.

Results

Sample Characteristics

A total of 687 federal public managers were invited across five successive waves of random sampling from a national roster of approximately 1,100 officials. Of these, 87 provided informed consent, 82 met eligibility criteria (MMSE ≥ 24), and 70 completed all study procedures, constituting the final analytic sample. Further details regarding recruitment procedures and eligibility criteria are available in Supplementary Material S2.

Table 1 presents the demographic characteristics of the final sample. Participants were middle-aged (*M* = 48.97, *SD* = 7.37) and predominantly male (61.4%). The sample was highly educated, with 95.7% holding postgraduate degrees, including 27.1% with a master's degree and 28.6% with a doctoral degree.

Participants reported substantial leadership experience, with approximately 70% having more than six years of tenure and 35.7% reporting over ten years. Most were career civil servants (97.1%), and income levels reflected the seniority of the sample, with 60% reporting monthly income above R$20,000.

(Insert Table 1 about here)

Descriptive Results

Descriptive statistics for the study variables are presented in Table 2. EF composite scores, SEB skills, and TLA showed adequate variability and overall acceptable distributional properties for subsequent inferential analyses. Comprehensive information on task-level validity criteria, scoring procedures, and additional distributional diagnostics is available in Supplementary Material S3.

(Insert Table 2 about here)

Associations between Executive Functions, Social, Emotional and Behavioral Skills, and Transformational Leadership Attitudes

Correlation Analysis

Partial correlations controlling for age and education level among EF indicators, SE and ER, and TLA are presented in Table 3. Overall, both SEB indicators (SE and ER) showed moderate positive associations with TLA (r = .53, p < .001 for both). In contrast, global EF indicators showed consistently small and non-significant associations with TLA.

(Insert Table 3 about here)

As expected, SE and ER were strongly intercorrelated (r = .69, p < .001), suggesting shared social, emotional, and behavioral regulatory mechanisms. A modest negative association was also observed between IC and SE (r = − .30, p < .05), although this secondary pattern should be interpreted cautiously given the study's primary focus.

Taken together, these findings suggest a differential pattern in which social, emotional, and behavioral skills are more closely related to transformational leadership attitudes than performance-based executive function indicators.

Hierarchical Regression Models

Hierarchical multiple regression analyses were conducted to examine the incremental contributions of EF and SEB indicators to TLA, controlling for age and education level.

Age and education level accounted for a small proportion of variance in TLA (R^2 = .06). In the first preregistered model, the inclusion of the SEB indicators (SE and ER) substantially improved model fit, increasing the explained variance to R^2 = .33 (ΔR^2 = .27). In the final step, EF indicators (WM, IC, and DM) were added, producing only a modest additional increase in explained variance (R^2 = .39, ΔR^2 = .06).

In the second preregistered hierarchical model, EF indicators (WM, IC, and DM) were entered before the SEB indicators (SE and ER). Their inclusion did not meaningfully increase the explained variance (R^2 = .07, ΔR^2 = .01). In the final step, the addition of SE and ER substantially improved model fit, increasing the explained variance to R^2 = .39 (ΔR^2 = .32). The results for both preregistered models are presented in Table 4.

Across both preregistered models, SEB skills accounted for the largest incremental proportion of explained variance in TLA, whereas EF indicators showed negligible incremental contribution. ER emerged as the only significant predictor (β = .39, p = .031), while SE was positively but not significantly associated with TLA (β = .29, p = .122). No EF indicators meaningfully predicted TLA (all p > .05).

Bootstrap analyses (5,000 resamples) yielded highly consistent parameter estimates, supporting the stability of the regression findings despite the modest sample size.

(Insert Table 4 about here)

Exploratory associations (IC X Individualized consideration)

To further explore potential links between EF indicators and specific dimensions of TLA, partial correlations controlling for age and education level were examined between IC and the Providing Individualized Support (PIS) dimension. A significant positive association was observed (r = .32, p = .018), and bootstrap confidence intervals based on 5,000 resamples confirmed the robustness of this effect (95% CI [.08, .51]; see Table 5).

(Insert Table 5 about here)

Importantly, PIS was not significantly associated with SE (r = − .06, p > .05) or ER (r = .04, p > .05), suggesting that this exploratory finding reflects a more specific link between inhibitory control and leadership attitudes related to individualized consideration rather than a broader association with social, emotional, and behavioral skills. Overall, although EF indicators were not associated with global TLA scores, inhibitory control may play a more circumscribed, domain-specific role in leadership attitudes involving interpersonal support and follower-focused behaviors.

Discussion

Overview of the Study and Main Findings

Overall, the findings revealed substantial variability across the examined constructs and indicated that SEB skills — including social engagement (SE) and emotional resilience (ER) — were consistently associated with TLA, whereas EF showed a more selective and domain-specific pattern of associations.

Among the EF components (WM, IC, and DM), only IC was positively related to leadership attitudes reflecting individualized support. Taken together, these results suggest that SEB skills — particularly ER — may represent more robust correlates of TLA than performance-based cognitive control indicators in experienced public-sector leaders. By examining component-specific EF indicators and SEB skills conceptualized as functional competencies within a preregistered multimethod design, the present study advances prior integrative research on the psychological foundations of transformational leadership.

An important limitation concerns the potential influence of shared-method variance on the observed associations between SEB skills and TLA, as both variables were assessed using self-report measures. Although the multimethod design reduced common-method bias in the assessment of EF through

performance-based indicators, the use of the same response format for SEB and TLA may have inflated their observed relationships. Accordingly, the stronger predictive role of SEB skills should be interpreted with appropriate methodological caution.

H1 — Variability Hypothesis

The first hypothesis predicted that EF (WM, IC, and DM), SEB skills (SE and ER), and TLA would display sufficient variability at both global and indicator levels. The findings supported this expectation, with descriptive statistics indicating substantial dispersion across the examined constructs. This pattern suggests that the sample captured meaningful individual differences in cognitive functioning, social, emotional, and behavioral skills — including SE and ER — and leadership attitudes.

Such variability likely reflects the heterogeneous composition of the Brazilian federal public service, which includes professionals with diverse educational backgrounds, career trajectories, and organizational experiences. Prior research has linked this type of heterogeneity to differences in decision-making styles, emotional regulation, and leadership behavior (Balthazard et al., 2012; Edelson et al., 2018; Fatima et al., 2020). Similarly, meta-analytic evidence indicates that institutional environments, administrative traditions, and organizational cultures contribute to variability in leadership patterns within the public sector (Backhaus & Vogel, 2022).

In the Brazilian context, such variability may be further amplified by the country's continental dimensions and pronounced sociocultural and economic differences across regions (IBGE, 2024), which shape organizational resources, administrative challenges, and leadership demands in distinct ways. These structural disparities reinforce the relevance of examining individual differences in EF and SEB skills among federal public-sector leaders.

From a methodological standpoint, adequate variability across EF, SEB (including SE and ER), and TLA strengthens the interpretability of the correlational and regression findings, as it ensures sufficient dispersion to detect meaningful associations among variables. Most constructs also showed approximately normal distributions, with only mild deviations observed for TLA and DM. Overall, these distributional properties support the suitability of the data for the inferential analyses conducted in this study.

H2 — Executive Functions and Transformational Leadership Attitudes

The second hypothesis predicted that EF would be positively associated with TLA. The findings provided selective support for this expectation. Regression analyses including WM, IC, and DM did not reveal consistent associations with global leadership attitudes. However, exploratory analyses indicated that IC was positively associated with leadership attitudes related to individualized consideration.

This pattern suggests that specific executive processes, rather than EF more broadly, may be particularly relevant for certain leadership-related behaviors. Individualized consideration involves attending to followers' needs, supporting their development, and managing complex interpersonal dynamics (Avolio & Bass, 2004), all of which may require the regulation of automatic responses and sustained goal-directed engagement in socially demanding contexts.

IC supports impulse regulation, response suppression, and reflective behavior (Diamond, 2013; Friedman & Miyake, 2017; Miyake & Friedman, 2012). Accordingly, leaders with stronger inhibitory control may be better able to modulate immediate reactions, consider alternative perspectives, and engage in more deliberate and adaptive interpersonal decision-making.

These findings align with theoretical accounts proposing that executive control contributes to adaptive leadership through reflective judgment and strategic regulation in complex organizational settings (Chan et al., 2021; Edelson et al., 2018). At the same time, prior neuropsychological research suggests that EF–leadership associations may be component-specific and context-dependent (Ramchandran et al., 2016), reinforcing the view that the cognitive foundations of leadership attitudes operate through selective executive mechanisms rather than uniformly across EF domains.

H3 — Social, Emotional, and Behavioral Skills and Transformational Leadership Attitudes

The third hypothesis predicted that SEB skills would be positively associated with TLA, particularly through the SE and ER dimensions. The findings provided strong support for this expectation, as both SE and ER showed moderate positive associations with leadership attitudes, with ER emerging as the only significant predictor in the regression models.

These results are consistent with a substantial body of research highlighting the importance of socio-emotional competencies — such as empathy, emotional regulation, and interpersonal effectiveness — for adaptive leadership behavior (Cavaness et al., 2020; Gómez-Leal et al., 2022; Humphrey et al., 2016). Transformational leadership involves motivating followers, fostering trust, and demonstrating individualized consideration (Avolio & Bass, 2004), all of which require the ability to regulate emotional responses and maintain constructive interpersonal relationships.

Overall, the present findings reinforce the view that social, emotional, and behavioral skills represent proximal foundations of transformational leadership attitudes in organizational contexts, particularly among experienced public-sector leaders.

H4 — Joint Contributions of Executive and Social, Emotional, and Behavioral Processes

The fourth hypothesis proposed that EF and SEB skills would jointly relate to transformational leadership attitudes through a potentially complex pattern of associations. The findings provided partial support for this integrative perspective. SEB skills showed consistent and robust associations with TLA, whereas EF demonstrated a more selective and domain-specific pattern, primarily involving inhibitory control.

This asymmetrical pattern suggests that leadership attitudes may reflect complementary regulatory processes rather than equivalent contributions from cognitive and social, emotional, and behavioral domains. SEB skills appear to provide proximal interpersonal foundations of transformational leadership, supporting constructive engagement with followers and effective emotional regulation. In contrast, executive control processes — particularly inhibitory control — may play a more circumscribed role by facilitating reflective judgment and the regulation of automatic responses in demanding organizational contexts.

These findings align with integrative leadership models emphasizing the interaction between cognitive control and socio-emotional functioning in shaping adaptive leadership behavior (Connelly & Ruark, 2010; Humphrey et al., 2016; Molenberghs et al., 2017). Building on this perspective, Fig. 1 presents a heuristic integrative model in which cognitive control processes and SEB skills contribute to TLA through complementary pathways. Although partially supported by the present findings, this framework should be interpreted as a conceptual guide for future research.

(Insert Fig. 1 about here)

Particularly, longitudinal and experimental investigations adopting multimethod approaches similar to the present design may help clarify the dynamic and potentially interactive effects of EF and SEB on leadership development and performance. Taken together, the results highlight the importance of advancing integrative investigations of cognitive and social, emotional, and behavioral mechanisms in leadership research while recognizing that their contributions may differ in magnitude and specificity.

Strengths and Limitations

This study presents several strengths. First, it examined the associations between EF, SEB, and TLA within a real-world population of federal public managers, providing ecologically valid insights into leadership-related processes in the public sector. To the best of our knowledge, this is among the first studies in Brazil to investigate transformational leadership using performance-based cognitive measures derived from cognitive neuroscience in a nationally distributed sample of public-sector leaders.

Second, the preregistered analytical plan enhanced transparency, reduced researcher degrees of freedom, and strengthened the methodological rigor of the findings. Third, the integration of performance-based cognitive measures and validated self-report SEB instruments provided a multimethod perspective on leadership-related processes, broadening construct representation and partially mitigating shared-method bias.

Nevertheless, several limitations should be acknowledged. First, the cross-sectional design precludes causal inference regarding the associations between EF, SEB, and TLA. Longitudinal and experimental studies are needed to clarify the temporal dynamics and potential causal pathways linking cognitive control, social, emotional, and behavioral skills, and leadership behavior. Second, the final sample size was slightly smaller than originally anticipated in the preregistration. However, the observed effect sizes exceeded those assumed in the a priori power estimation (estimated $f^2 = .15$ vs. observed $f^2 = .39$), suggesting that the study was adequately powered to detect the effects identified.

Third, performance-based EF tasks — particularly digital adaptations — may involve task impurity, as individual tasks can recruit multiple cognitive processes beyond the targeted executive component. Fourth, the sample showed limited variability in educational background, which may constrain generalizability to populations with broader educational diversity, although this characteristic reflects the typical profile of senior public managers in the Brazilian federal administration. Finally, the reliance on self-report measures for both SEB indicators and TLA may have inflated observed associations due to shared-method variance.

Directions for Future Research

Future research may advance the understanding of the associations between EF, SEB skills, and leadership by addressing several directions suggested by the present findings. First, longitudinal designs are needed to clarify the temporal dynamics linking cognitive control processes, social, emotional, and behavioral skills, and leadership development. Such approaches could examine whether improvements in EF and SEB precede changes in leadership attitudes or whether these associations evolve reciprocally over time.

Second, experimental and intervention-based studies may investigate whether targeted training programs aimed at strengthening EF, particularly IC, and SEB skills contribute to the development of leadership-related capabilities. Cognitive training interventions focusing on inhibitory control, alongside programs designed to enhance emotional regulation and interpersonal effectiveness, may help clarify the malleability of leadership-related psychological processes.

Third, future studies could extend the present heuristic integrative framework illustrated in Fig. 1 by incorporating neurophysiological and neuroimaging measures, as well as behavioral indicators of leadership performance. Such approaches may help elucidate the neural and cognitive mechanisms underlying leadership behavior and provide a more comprehensive understanding of how cognitive control and SEB skills jointly contribute to adaptive leadership in complex organizational environments.

Finally, examining these associations across more diverse organizational contexts and populations — including private-sector leaders and cross-cultural samples — will be important to assess the generalizability of the present findings and identify potential contextual moderators.

Practical Implications

These findings have direct implications for management development and leadership training in public-sector organizations. The consistent associations between SEB skills and TLA indicate that training initiatives should prioritize the development of emotional regulation, interpersonal awareness, and social engagement. Strengthening these competencies may foster leadership behaviors that enhance motivation, trust, and team effectiveness.

The selective association between inhibitory control and individualized consideration suggests that cognitive self-regulation supports reflective and adaptive interpersonal leadership. Accordingly, leadership development programs may benefit from incorporating targeted cognitive training strategies aimed at strengthening executive control processes, particularly inhibitory control and working memory, to support decision-making in complex organizational environments.

In addition, performance-based cognitive assessments, such as the digital EF battery used in this study, may provide practical tools for identifying regulatory demands and informing targeted interventions to support leadership effectiveness in public organizations.

Conclusion

The study advances the understanding of transformational leadership by integrating performance-based executive function indicators and social, emotional, and behavioral skills within a preregistered multimethod framework applied to a national sample of public-sector leaders. The findings indicate that SEB skills represent proximal foundations of leadership attitudes, whereas executive control processes contribute in a more selective manner.

This pattern supports integrative perspectives suggesting that effective leadership emerges from complementary regulatory mechanisms rather than uniform effects across psychological domains. By highlighting the distinct and potentially interactive roles of cognitive control and SEB functioning, the study contributes to a more nuanced and practice-relevant understanding of leadership in public-sector contexts.

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Tables

Table 1

Demographic Characteristics of the Final Sample (N = 70)

Variable	N (%) or M (SD)
Age	48.97 (7.37)
Sex	
Male	43 (61.4%)
Female	27 (38.6%)
Race	
Black	3 (4.3%)
Brown	14 (20.0%)
White	53 (75.7%)
Education	
Bachelor’s degree	3 (4.3%)
Postgraduate specialization	28 (40.0%)
Master’s degree	19 (27.1%)
Doctoral degree	20 (28.6%)
Marital Status	
Married	60 (85.7%)
Separated	2 (2.9%)
Single	8 (11.4%)
Leadership tenure	
1-2 years	3 (4.3%)
3-5 years	18 (25.7%)
6-10 years	24 (34.3%)
> 10 years	25 (35.7%)
Administrative span of control	
No direct reports	1 (1.5%)
1-5 employees	7 (10.0%)
6-10 employees	12 (17.1%)
11-20 employees	14 (20.0%)
21-50 employees	19 (27.1%)
51-100 employees	6 (8.6%)

Variable	N (%) or M (SD)
101-200 employees	5 (7.1%)
> 200 employees	6 (8.6%)
Employment type	
Career civil servant	68 (97.1%)
Comissioned	2 (2.9%)
Income	
R$ 4,001.00-R$ 8,000.00	4 (5.7%)
R$ 8,001.00-R$ 12,000.00	4 (5.7%)
R$ 12,001.00-R$ 16,000.00	6 (8.6%)
R$ 16,001.00-R$ 20,000.00	14 (20.0%)
> R$ 20,000.00	42 (60.0%)

Table 2

Descriptive Statistics of Study Variables

Variable	N	Mean	SD	Skewness	Kurtosis	Reliability
Age	70	48.97	7.37	0.50	0.60	--
Education level[a]	70	2.80	0.91	0.06	-1.19	--
WM composite	61	-0.02	0.60	-0.23	-0.41	--
IC composite	56	0.00	0.47	-0.57	0.86	--
DM composite	70	0.00	0.91	0.38	-0.44	--
CF[b] composite	70	0.00	0.32	-0.21	-0.49	--
SE	70	0.00	1.00	-0.57	0.34	α = .93 (ω = .93)
ER	70	0.00	1.00	-0.20	-0.49	α = .96 (ω = .97)
TLA	70	0.00	1.00	-0.53	-0.46	α = .82 (ω = .86)

Note. WM = working memory; IC = inhibitory control; DM = decision-making; CF = cognitive flexibility; SE = social engagement; ER = emotional resilience; TLA = transformational leadership attitudes. All EF variables are composite scores derived from multiple performance-based EF task indicators (see supplementary material S3). [a] Education level is coded from 1 (bachelor's degree) to 4 (doctoral degree). [b] CF was examined as an exploratory EF component.

Table 3

Partial Correlations among EF, Social, Emotional, and Behavioral Skills, and Transformational Leadership Attitudes, Controlling for Age and Education Level

	WM	IC	DM	SE	ER	TLA
WM	—					
IC	-0.11	—				
DM	0.13	-0.24	—			
SE	0.07	-0.30*	0.14	—		
ER	0.06	-0.26	-0.02	0.69***	—	
TLA	0.03	0.02	0.06	0.53***	0.53***	—

Note. Partial correlations controlling for age and education level. WM = working memory; IC = inhibitory control; DM = decision making; SE = social engagement; ER = emotional resilience; TLA = transformational leadership attitudes. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 4

Hierarchical Multiple Regression Predicting Transformational Leadership Attitudes

Predictor	β	95% CI	p
Covariates			
Age	-.11	[-0.37, 0.16]	.43
Education	-.19	[-0.33, 0.19]	.58
SEB indicators			
SE	.29	[-0.08, 0.64]	.12
ER	.39	[0.04, 0.74]	.03
EF indicators			
WM	.06	[-0.21, 0.34]	.64
IC	.25	[-0.03, 0.52]	.08
DM	-.02	[-0.30, 0.25]	.86
Model summary	R^2	ΔR^2	
Step 1 (covariates)	.058	--	
Model 1 (SEB → EF)			
Step 2 (SEB)	.330	.272	
Step 3 (EF)	.385	.055	
Model 2 (EF → SEB)			
Step 2 (EF)	.065	.007	
Step 3 (SEB)	.385	.320	

Note. β = standardized coefficient; CI = confidence interval; SEB = social, emotional, and behavioral skills; EF = executive functions; SE = social engagement; ER = emotional resilience; WM = working memory; IC = inhibitory control; DM = decision-making under risk and uncertainty.

Table 5

Bootstrap Partial Correlation between Inhibitory Control and Providing Individualized Support (TLA Dimension), Controlling for Age and Education Level

Association	n	Pearson's r	p	95% CI	Effect size	
					Fisher's z	SE (z)
IC X PIS	56	.32	.018	[.075, .513]	.33	.14

Note. Partial correlation controlling for age and education level. Confidence intervals based on 5,000 bootstrap resamples. IC = inhibitory control composite score; PIS = Providing Individualized Support.

Figures

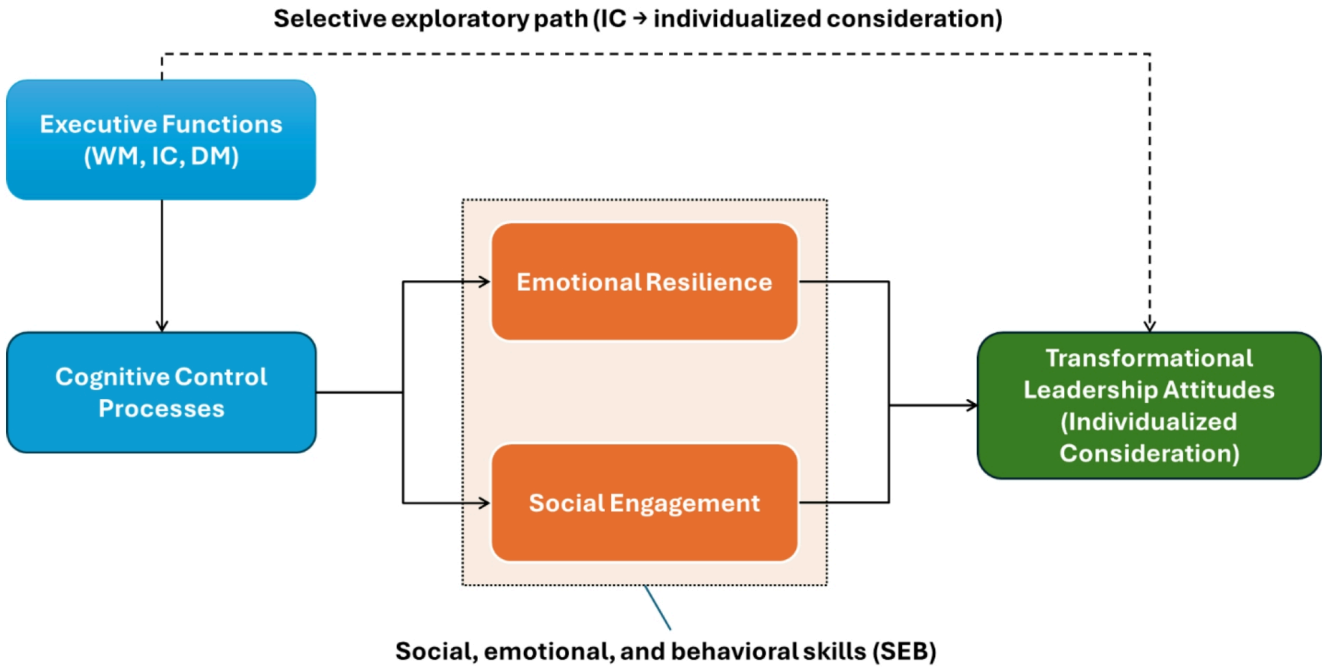


Figure 1

Conceptual Model Linking Executive Functions, Social, Emotional, and Behavioral Skills, and Transformational Leadership Attitudes

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- S1TemporalconfigurationEFdigitaltools.docx
- S2Participantrecruitmentwaveseligibilitystatusprotocolcompletionandanalyticalinclusion.xlsx
- S3Taskleveldescriptivediagnosticsandvaliditycriteria.docx