

# Prediction of Cognitive Flexibility Based on Attention Control, Working Memory, and Problem-Solving Skills in Adolescents Using CatBoost

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## 1. Round 1

### 1.1. Reviewer 1

Reviewer:

In the Introduction, the sentence “Cognitive flexibility has received increasing attention in developmental cognitive neuroscience because it reflects the adolescent’s capacity to move beyond rigid response patterns and engage in adaptive, context-sensitive cognition” is conceptually strong, but the manuscript should define cognitive flexibility more operationally. Since the study uses a self-report cognitive flexibility measure, the authors should clarify whether cognitive flexibility is being treated as perceived flexibility, behavioral flexibility, executive shifting, or adaptive coping flexibility. This distinction is important because questionnaire-based cognitive flexibility may not fully correspond to task-based executive flexibility.

In the paragraph discussing “distributed neural systems involved in control, salience detection, attentional shifting, and integration of internal and external information,” the discussion is scientifically relevant but somewhat broad for the present study. The manuscript does not include neuroimaging or biological measures; therefore, the authors should be cautious not to overextend neurodevelopmental claims. I suggest revising this paragraph to state that neurodevelopmental evidence provides

a theoretical background, while the present study specifically examines psychological and self-report indicators of executive functioning.

In the Introduction, the paragraph beginning with “The broader literature on executive functioning shows that cognitive flexibility is closely connected with other cognitive processes” appropriately situates the study within executive function theory. However, the authors should more explicitly differentiate attention control, working memory, and problem-solving skills from cognitive flexibility to avoid conceptual overlap. For example, the manuscript should explain how each predictor is theoretically distinct from the dependent variable and why multicollinearity is not expected to invalidate the predictive model.

In the Data Collection Tools section, the paragraph on the Problem-Solving Inventory states that the instrument assesses “perceptions of their problem-solving ability rather than their actual performance.” This limitation should be integrated more explicitly into the methodology and discussion. Because all variables appear to be self-reported, the observed associations may partly reflect shared method variance rather than true cognitive performance. The authors should acknowledge this and consider including objective or performance-based executive function tasks in future versions of the study.

In the Data Analysis paragraph, the sentence “Before model training, the dataset was randomly divided into training and testing subsets, with 80% of the data used for training and 20% used for testing” should be expanded. The authors should report whether the split was stratified by gender or age, whether a fixed random seed was used, and whether preprocessing steps such as missing data handling, outlier treatment, and scaling were performed before or after splitting. This detail is essential to ensure reproducibility and prevent information leakage.

In the Data Analysis section, the statement “Model tuning was conducted by adjusting key hyperparameters, including learning rate, depth, number of iterations, and regularization parameters” is insufficiently detailed for a machine learning manuscript. The authors should report the search strategy, the range of hyperparameters tested, the final selected values, and whether tuning was performed through cross-validation within the training set. Without these details, the CatBoost model cannot be reproduced by other researchers.

Authors uploaded the revised manuscript.

## 1.2. Reviewer 2

Reviewer:

In the Introduction, the sentence “Problem-solving skills are also conceptually and empirically related to cognitive flexibility” is important, but the manuscript should explain the directionality of this relationship more carefully. It remains unclear whether problem-solving skills are assumed to predict cognitive flexibility, whether cognitive flexibility enables effective problem solving, or whether the two constructs mutually reinforce each other. Since the study is predictive and cross-sectional rather than causal, the authors should avoid causal language and frame the association as statistical prediction rather than developmental influence.

In the final gap paragraph of the Introduction, the authors state that “there is a need for culturally and educationally contextualized research among adolescents in Tehran.” This is a valuable claim, but it requires stronger elaboration. The manuscript should specify what features of the Tehran educational context make this study necessary, such as academic competition, school structure, urban diversity, or adolescent educational pressure. Without this explanation, the geographical focus appears descriptive rather than theoretically or practically justified.

In the Methods section, the paragraph beginning with “This study was conducted using a quantitative, descriptive-correlational, and predictive design” is generally appropriate, but the manuscript should clarify whether the predictive component is exploratory, confirmatory, or model-comparison based. Since CatBoost is used as the primary predictive algorithm, the authors should specify whether the model was chosen a priori, whether other algorithms were compared, and whether hyperparameter tuning was performed only within the training data to prevent data leakage.

In the Study Design and Participants paragraph, the sentence “The final sample included exactly 384 adolescents aged 13 to 18 years” should be supported by a sample size rationale. The authors should explain how 384 participants were determined, whether through Cochran’s formula, power analysis, sample-to-feature ratio, or practical recruitment considerations. This is

especially important because machine learning models require sufficient sample size not only for statistical significance but also for stable prediction and generalizability.

In the Methods section, the sentence “Using multistage cluster sampling, several educational districts were first selected from Tehran, then schools were randomly chosen from each district, and finally eligible students were invited to participate” needs additional procedural detail. The authors should report the number of districts, number of schools, number of classrooms, and approximate number of students approached before exclusions. Without this information, it is difficult to evaluate sampling representativeness and potential selection bias.

In the Methods section, the exclusion criterion “reported history of severe neurological or psychiatric disorders” requires clarification. The authors should state how this information was obtained, whether by self-report, parent report, school records, or screening questionnaire. Given that executive functions are sensitive to psychiatric, neurological, sleep, and developmental conditions, the validity of this exclusion process affects the interpretation of the findings.

In the Data Collection Tools section, the paragraph describing the Cognitive Flexibility Inventory states that “previous studies have reported acceptable validity and reliability,” but the manuscript should provide psychometric evidence specific to the language and cultural context of the present sample. If a Persian version was used, the authors should report its source, translation procedure, validation evidence, and reliability coefficients in Iranian adolescent populations. If the scale was translated for this study, forward–backward translation and content validity procedures should be described.

In the Data Collection Tools section, the description of the Working Memory Questionnaire is too general. The sentence “Working memory was assessed using the Working Memory Questionnaire developed to evaluate everyday manifestations of working memory functioning” does not identify the original authors, number of items, subscales, scoring range, or interpretation direction. The authors should specify the exact instrument used, because “Working Memory Questionnaire” may refer to different tools in the literature.

Authors uploaded the revised manuscript.

## 2. Revised

Editor’s decision after revisions: Accepted.

Editor in Chief’s decision: Accepted.