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Chapter 12: Family Communication and Emotional Regulation among Adolescents

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Abstract— Adolescence is characterized by substantial changes in emotional reactivity, social relationships, autonomy, and patterns of family interaction. This study examines how the quality and structure of family communication relate to adolescents' capacity to recognize, modulate, and recover from emotionally challenging experiences. A distinctive research gap is identified in the limited integration of conventional psychosocial measures with computational modelling capable of detecting nonlinear communication–emotion relationships. The proposed research conceptualizes family communication through openness, emotional validation, perceived parental responsiveness, conflictual interaction, and communication consistency rather than treating communication as a single global construct. Emotional regulation is similarly examined through adaptive regulation, cognitive reappraisal, expressive suppression, emotional awareness, and regulation difficulty.

The study proposes a multimodal analytical framework combining validated questionnaire measures with privacy-preserving linguistic indicators derived from structured family-interaction scenarios and machine-learning analysis.

Keywords— Family Communication, Emotional Regulation, Adolescents, Digital Health, Explainable Machine Learning, Affective Computing

Introduction

Adolescence represents a developmental period in which emotional experiences become increasingly complex while the social contexts in which emotions are interpreted and expressed undergo substantial change. Young people progressively negotiate autonomy, peer relationships, academic expectations, identity development, and greater exposure to digitally mediated social environments. These transitions do not occur independently of family life. Even as adolescents become more socially independent, family interactions remain an important environment in which emotions are labelled, interpreted, expressed, challenged, validated, or suppressed.

Family communication is therefore more than the transmission of information between parents and children. It includes the degree to which adolescents perceive that they can discuss difficult experiences, whether caregivers respond with attention and validation, how disagreement is managed, and whether communication remains psychologically safe when emotions become intense. A family may communicate frequently while still providing limited opportunities for meaningful emotional disclosure. Conversely, relatively brief interactions may be emotionally supportive when they are characterized by

responsiveness, respect, and acknowledgement. This distinction suggests that communication frequency alone provides an incomplete representation of the family emotional environment.

Emotional regulation refers broadly to processes through which individuals influence the emergence, intensity, expression, duration, or interpretation of emotional states. During adolescence, regulatory strategies become increasingly differentiated. Cognitive reappraisal can involve changing the interpretation of an emotionally significant situation, whereas expressive suppression involves inhibiting the observable expression of emotion after it has arisen. Emotional regulation also encompasses awareness, acceptance, impulse control, access to appropriate strategies, and the ability to maintain goal-directed behaviour under emotional strain.

The family represents one of the earliest contexts in which these processes develop. Caregiver responses to distress can implicitly communicate whether an emotion is legitimate, manageable, threatening, or inappropriate. Repeated patterns of attentive listening and emotional validation may provide opportunities for adolescents to identify and reconsider emotional experiences. In contrast, persistent criticism, dismissal, hostile conflict, or unpredictable responses may complicate emotional processing. Importantly, these associations should not be interpreted as a simple deterministic pathway from parenting behaviour to adolescent outcomes. Adolescent temperament, socioeconomic conditions, family stress, cultural expectations, peer experiences, and reciprocal child–parent influences can all shape communication and regulation simultaneously.

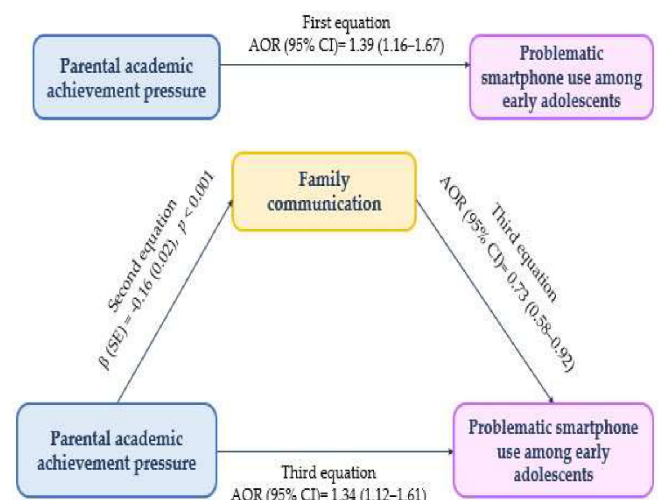


Fig. 1: The Mediating Role of Family Communication in the Relationship Between Academic Achievement Pressure and Problematic Smartphone Use Among Korean Early Adolescents

Source: <https://www.mdpi.com/2227-9067/12/9/1141>

The contemporary digital environment adds another layer to this relationship. Adolescents increasingly move between face-to-face and technology-mediated communication. Family conversations can occur through messaging platforms, voice calls, shared digital spaces, and brief online interactions in addition to conventional conversation. At the same time, digital-health research has begun exploring computational methods for modelling behavioural and psychosocial signals. Machine learning (ML), natural-language processing (NLP), and affective computing offer methodological opportunities to investigate multidimensional relationships that may not be adequately represented by a single correlation coefficient or linear regression model.

However, applying artificial intelligence to adolescent emotional research also presents substantial methodological and ethical challenges. Emotional states cannot be reliably inferred from isolated words, facial expressions, or digital traces without context. Models trained on restricted demographic or linguistic populations may perform poorly across cultural groups. Data involving minors and family communication are particularly sensitive. Consequently, computational methods should augment validated psychological assessment rather than operate as autonomous diagnostic systems.

1.1 Research Gap

Three limitations provide the foundation for the present research.

First, a substantial portion of family–adolescent research relies on global scores of family functioning or communication. Such aggregation can conceal potentially different roles of **communication openness, emotional validation, parental responsiveness, conflict intensity, and communication consistency**. Two adolescents with similar overall communication scores may therefore experience substantially different emotional climates.

Second, conventional statistical models commonly assume additive or approximately linear relationships. Family processes may instead involve interaction effects and thresholds. For example, high communication frequency may not be beneficial when conversations are consistently hostile, while moderate communication accompanied by strong emotional validation may have a different association with regulation. Interpretable ML provides a means of examining such nonlinearities without replacing theoretically grounded statistical analysis.

Third, computational adolescent mental-health research has often concentrated on individual digital behaviour, including social-media activity, smartphone use, or personal language patterns. Comparatively less attention has been directed toward **family-level communication signals as contextual predictors of adolescent emotional-regulation profiles**, particularly within frameworks that explicitly emphasize interpretability, privacy, and developmental appropriateness.

The proposed study addresses this intersection by combining psychometrically grounded measures of family communication and emotional regulation with structured, privacy-preserving communication features. Rather than attempting to diagnose adolescents, the computational component is designed to test

whether multidimensional family communication provides incremental predictive information concerning regulation profiles.

1.2 Research Objective

The primary objective is to develop and evaluate an interpretable computational framework for examining the association between multidimensional family communication and emotional regulation among adolescents.

More specifically, the research investigates whether communication openness, perceived emotional validation, parental responsiveness, conflictual communication, and communication consistency explain variation in emotional-regulation outcomes after accounting for relevant background characteristics. A secondary objective is to determine whether nonlinear ML models provide meaningful predictive improvement over conventional statistical baselines and, if so, which features contribute to that improvement.

This formulation differs from studies that merely ask whether “good family communication” correlates with “better emotional health.” The intended contribution is to identify **which aspects of communication matter, under what combinations, and how reliably these patterns can be modelled without converting probabilistic associations into psychological diagnoses**.

Literature Review

2.1 Family Communication as a Developmental Context

Family communication can be conceptualized as a relational process through which family members exchange information, expectations, emotional meanings, and interpersonal feedback. From a developmental perspective, its significance lies partly in the repeated opportunities it creates for social learning. Adolescents observe how adults respond to frustration, negotiate disagreements, express vulnerability, and recover from interpersonal conflict.

Communication openness is particularly relevant because disclosure requires a perception of interpersonal safety. Adolescents who expect ridicule, punishment, immediate judgment, or dismissal may selectively withhold emotionally significant information. In contrast, perceived parental responsiveness may facilitate discussion of difficult experiences by signalling that emotional disclosure will receive attention rather than automatic rejection.

Communication must therefore be differentiated from parental monitoring. Monitoring concerns parental knowledge and supervision, whereas emotionally meaningful communication concerns how information is exchanged and interpreted. High levels of parental knowledge may coexist with limited emotional openness. Similarly, an adolescent can interact frequently with family members while perceiving little emotional validation.

The post-2021 literature has increasingly situated family relationships within broader environments shaped by pandemic-related disruptions, changes in schooling, intensified digital communication, and evolving patterns of adolescent socialization. These developments strengthen the case for treating communication as a dynamic, multidimensional process rather than a fixed family characteristic.

2.2 Emotional Regulation during Adolescence

Gross's process-oriented account of emotion regulation distinguishes strategies according to when they intervene in the emotion-generative process. Cognitive reappraisal occurs relatively early by modifying the interpretation of a situation, whereas expressive suppression operates later by limiting outward emotional expression. This distinction remains important because regulatory strategies can differ in their cognitive, interpersonal, and affective consequences.

For adolescents, emotional regulation is particularly significant because regulatory capacities continue to develop alongside changing social demands. A young person must increasingly manage frustration without immediate caregiver intervention, interpret ambiguous peer behaviour, respond to academic setbacks, and navigate conflicting expectations across home, school, and online settings.

Nevertheless, emotional regulation should not be reduced to the suppression of negative affect. Adaptive regulation can involve recognizing emotions, tolerating temporary distress, modifying interpretations, seeking appropriate social support, and selecting context-sensitive behavioural responses. Accordingly, the proposed study treats regulation as multidimensional rather than assuming that low negative-emotion expression necessarily indicates successful regulation.

2.3 Family Emotional Socialization and Regulatory Development

Family emotional socialization provides a theoretical mechanism linking communication with regulation. Parents and caregivers influence emotional development through modelling, explicit discussion, reactions to adolescents' emotions, and the emotional climate of everyday family life. When caregivers acknowledge emotions and encourage constructive interpretation, adolescents receive repeated opportunities to develop emotional vocabulary and regulation strategies.

Conversely, dismissive or punitive responses can communicate that particular emotions should be hidden rather than understood. Chronic hostile conflict may also increase emotional arousal during precisely those interactions in which regulation is required. The association is unlikely to be uniformly linear, however. Conflict itself is not necessarily maladaptive; disagreement managed through respectful negotiation may provide adolescents with opportunities to practise regulation.

A more informative research design must therefore distinguish **constructive disagreement from destructive communication**. The present framework operationalizes conflict communication in terms of hostility, interruption, perceived invalidation, and unresolved escalation rather than merely recording whether disagreements occur.

2.4 Communication Openness, Validation, and Parental Responsiveness

Openness allows adolescents to articulate emotional experiences before those experiences become behaviourally expressed. Emotional validation, meanwhile, involves acknowledging the intelligibility of another person's emotional

response without necessarily agreeing with every interpretation or action. These constructs are related but not interchangeable. Parental responsiveness introduces another dimension. An adolescent may perceive that a caregiver permits disclosure but does not respond meaningfully to it. Conversely, caregivers may be highly responsive to practical matters while remaining uncomfortable discussing emotional concerns. Separating these constructs is therefore analytically useful.

The proposed model hypothesizes that combinations of communication dimensions may be more informative than any dimension considered independently. For example, openness combined with validation may have a stronger association with adaptive regulation than openness in a highly critical environment. Such conditional relationships provide a rationale for supplementing traditional regression with nonlinear modelling.

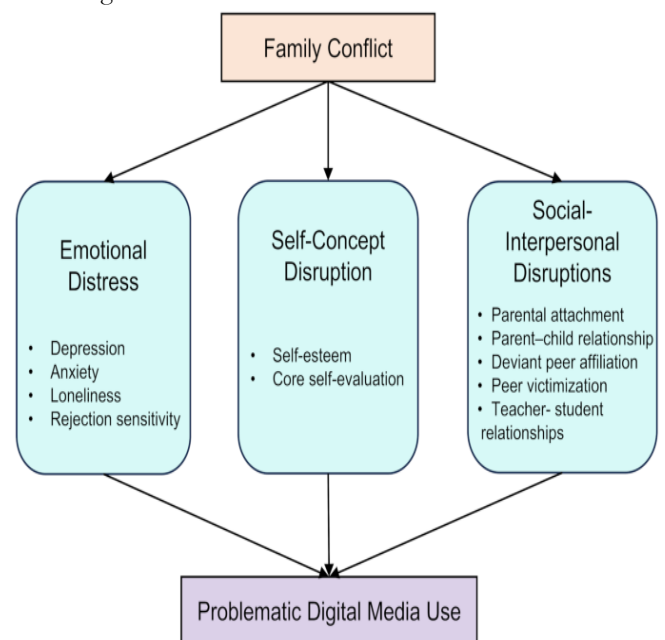


Fig. 2: Family Conflict is Associated with Increased Risk of Problematic Digital Media Use in Children and Adolescents

Source: <https://link.springer.com/article/10.1007/s40894-025-00274-2>

2.5 Digital Communication and Contemporary Family Interaction

Digital communication has altered the temporal and spatial structure of family interaction. Parents and adolescents can exchange information while physically separated, and emotionally significant discussions may begin through text before continuing face to face. Digital communication can facilitate connection, but it can also remove nonverbal contextual information and increase ambiguity.

For research purposes, this hybrid communication environment creates methodological difficulties. Direct collection of private family messages would raise substantial privacy concerns, particularly when minors are involved. The present study therefore avoids unrestricted surveillance of personal communication. Instead, its proposed computational component uses responses generated within controlled communication scenarios, from which limited linguistic characteristics can be derived after de-identification.

This design enables examination of communication features without requiring investigators to collect participants' historical private conversations. Such data minimization is particularly important in digital-health research involving adolescents.

2.6 Artificial Intelligence and Computational Assessment of Psychosocial Processes

Machine-learning approaches can detect complex relationships among multiple predictors and accommodate interactions that may be difficult to prespecify in traditional models. Tree-based ensemble algorithms, regularized models, and interpretable boosting methods can therefore provide complementary perspectives on family-process data.

Yet predictive accuracy alone is inadequate for psychosocial research. A model may achieve satisfactory discrimination while learning demographic proxies or dataset-specific artefacts. Interpretability techniques are consequently necessary for examining the contribution and direction of predictors. Feature-attribution methods can indicate which variables contribute to predictions, while partial-dependence or accumulated-local-effect approaches can help assess potential nonlinear relationships.

The proposed study adopts a deliberately constrained use of AI. Psychological scale scores remain the principal measurement foundation. Computational linguistic indicators are treated as supplementary predictors, and model performance is compared against simpler statistical baselines. This permits researchers to determine whether algorithmic complexity provides genuine incremental value.

2.7 Explainability, Fairness, and Privacy

The use of adolescent data creates additional responsibilities. Family communication can reveal sensitive information concerning relationships, conflict, socioeconomic circumstances, or psychological distress. Therefore, the research design should incorporate informed parental consent where legally required, adolescent assent, data minimization, pseudonymization, restricted access, and clearly specified retention procedures.

Fairness is equally relevant. Language and emotional expression vary across gender, culture, socioeconomic setting, family structure, and linguistic background. A model trained predominantly on one population could mistake cultural communication norms for indicators of regulatory difficulty. Subgroup performance should therefore be evaluated rather than assuming that overall accuracy demonstrates equitable validity.

Explainability cannot completely resolve these concerns, but it can expose suspicious dependencies. If predictions are disproportionately driven by demographic attributes rather than theoretically relevant communication variables, researchers would have evidence that the model requires reconsideration.

2.8 Conceptual Framework and Research Questions

The literature supports a conceptual pathway in which family communication operates as a contextual correlate of adolescents' regulatory development, while individual and demographic characteristics function as potential covariates. The framework proposed for this study can be expressed as:

Family Communication Dimensions → Emotional Processing Environment → Emotional-Regulation Profile
with communication dimensions represented by:

Openness + Validation + Responsiveness + Consistency – Destructive Conflict

The computational layer examines whether combinations of these variables improve prediction beyond conventional demographic and psychosocial baselines.

Accordingly, Part 2 will test four central research questions:

RQ1: Which dimensions of family communication demonstrate the strongest associations with adaptive and maladaptive emotional-regulation patterns among adolescents?

RQ2: Does multidimensional family communication provide incremental predictive information beyond demographic and individual background variables?

RQ3: Do nonlinear machine-learning models produce meaningful out-of-sample improvement over interpretable linear baselines?

RQ4: Which communication variables and interactions are identified as influential by explainability analysis, and are these patterns stable across relevant participant subgroups?

These questions establish a research design in which AI functions as an analytical instrument rather than a substitute for psychological theory or clinical assessment.

Proposed Methodology

The study adopts a **multimodal cross-sectional predictive design** integrating psychometric assessment, structured family-communication scenarios, and explainable machine learning. The central analytical objective is not to diagnose psychological disorders but to estimate individual differences in emotional-regulation difficulty from theoretically meaningful characteristics of family communication.

Recent longitudinal evidence indicates that parent–adolescent communication concerning emotional distress can predict subsequent emotion-regulation difficulties, while machine-learning research has demonstrated that relationship quality and parent–adolescent conflict can contribute to predictions of emotion-regulation development. These findings justify testing a multidimensional computational model rather than treating family communication as a single aggregate variable.

3.1 Participants and Sampling

For the proposed empirical implementation, a target sample of **480 adolescents aged 13–18 years** would be recruited from secondary and senior-secondary educational institutions using stratified multistage sampling. Stratification would seek adequate representation across age groups, gender, school type, and urban/semi-urban settings.

Participants would complete measures independently under standardized conditions. Because the research involves minors and potentially sensitive family information, institutional ethics approval, adolescent assent, and parent/guardian consent would be obtained as applicable.

The dataset would contain three principal information domains:

1. **Family communication:** openness, emotional validation, caregiver responsiveness, communication consistency, and destructive conflict.

2. **Emotional regulation:** cognitive reappraisal, expressive suppression, emotional awareness, impulse-control difficulty, and access to regulation strategies.
3. **Contextual covariates:** age, gender, family structure, perceived family stress, daily digital communication with caregivers, and selected socioeconomic indicators.

No private social-media accounts or historical messaging conversations would be collected.

3.2 Measurement Strategy

Family communication would be assessed through validated family-communication items supplemented by standardized scenario-based questions. Adolescents would respond to hypothetical situations involving academic disappointment, interpersonal conflict, anxiety about performance, and disagreement with caregivers.

Emotional regulation would be operationalized primarily through validated questionnaire scores measuring regulation difficulty and adaptive strategies. This avoids the methodological problem of defining emotion regulation entirely from computationally inferred behavioural signals.

A standardized **Emotional Regulation Difficulty Index (ERDI)** would serve as the principal continuous outcome. Higher ERDI values would indicate greater regulation difficulty. A secondary three-level profile—adaptive, intermediate, and elevated difficulty—could be generated for exploratory classification analysis using prespecified thresholds derived from the study distribution rather than presented as clinical categories.

Experimental Setup

4.1 Dataset Construction

After recruitment, incomplete or invalid submissions would be screened according to a preregistered protocol. Assuming approximately 5% of records fail quality-control criteria, a sample of roughly **450–460 analytically usable observations** could remain. This number is an anticipated design quantity, not an observed result.

The dataset would include psychometric variables together with a small set of privacy-preserving linguistic features obtained from participants' responses to structured scenarios. Linguistic features would include:

- response length;
- emotional-word density;
- positive/negative affect balance;
- first-person pronoun frequency;
- validation-related expressions;
- conflict-related expressions;
- semantic indicators of support seeking.

Raw free-text responses would be pseudonymized and separated from participant identifiers.

4.2 Data Preprocessing

Preprocessing would be performed within training folds to prevent information leakage. Numerical missing values would be imputed using training-set medians when missingness remained within acceptable limits. Categorical missingness would be represented through an explicit unknown category where appropriate.

Continuous variables would be standardized for algorithms sensitive to feature scale. Highly redundant predictors would be identified using correlation and variance-inflation diagnostics. Psychometric reliability would be assessed before composite variables were generated.

Categorical predictors would be encoded without imposing arbitrary ordinal relationships. Linguistic features would undergo range normalization, and extreme observations would be examined rather than automatically removed.

Crucially, imputation, scaling, feature selection, and hyperparameter optimization would occur **after partitioning the data**, thereby ensuring that information from the held-out test set could not influence model construction.

4.3 Model Architecture

The primary model would use **Explainable Boosting Machine (EBM)** architecture. EBM is appropriate because it can model nonlinear predictor–outcome relationships while retaining greater interpretability than a conventional multilayer neural network.

Three comparison models would be constructed:

Model A – Elastic Net Regression: interpretable linear baseline.

Model B – Random Forest Regressor: nonlinear ensemble baseline.

Model C – Explainable Boosting Machine: principal proposed model.

The model input vector can be represented as:

$$\begin{bmatrix} O, V, R, C, K, D, S \end{bmatrix}$$

where:

- (O) = communication openness,
- (V) = emotional validation,
- (R) = caregiver responsiveness,
- (C) = destructive conflict,
- (K) = communication consistency,
- (D) = digital family-communication characteristics,
- (S) = selected contextual variables.

The predicted outcome is:

$$[\hat{Y} = f(X)]$$

where $(\hat{Y})$ represents the estimated ERDI.

A limited number of theoretically defensible pairwise interactions—particularly **openness × validation**, **conflict × responsiveness**, and **digital communication × responsiveness**—would be evaluated rather than permitting unrestricted interaction mining.

4.4 Training Strategy

Data would initially be separated into an **80% development set** and **20% untouched test set**, stratified where feasible by age and gender.

Within the development set, repeated five-fold cross-validation would be used for hyperparameter selection. This procedure would reduce dependence on a single train–validation split and provide more stable estimates of model variability.

Hyperparameters for the EBM would include learning rate, maximum bins, interaction count, and minimum samples per leaf. Random Forest tuning would include tree number, maximum depth, minimum leaf size, and feature subsampling. Elastic Net tuning would optimize the regularization magnitude and L1/L2 mixing parameter.

The final selected configuration would then be refitted to the entire development dataset and evaluated once on the untouched test sample.

4.5 Evaluation Metrics

Because ERDI is continuous, regression metrics would form the principal evaluation framework:

$$\left[MAE = \frac{1}{n} \sum_{i=1}^n |y_i - \hat{y}_i| \right]$$

$$\left[RMSE = \sqrt{\frac{1}{n} \sum_{i=1}^n (y_i - \hat{y}_i)^2} \right]$$

$$\left[R^2 = 1 - \frac{\sum (y_i - \hat{y}_i)^2}{\sum (y_i - \bar{y})^2} \right]$$

The analysis would additionally report **Spearman's rank correlation** between observed and predicted regulation scores because correct ordering of participants can remain informative when exact score prediction is imperfect.

Bootstrap confidence intervals would be calculated for major test-set performance estimates.

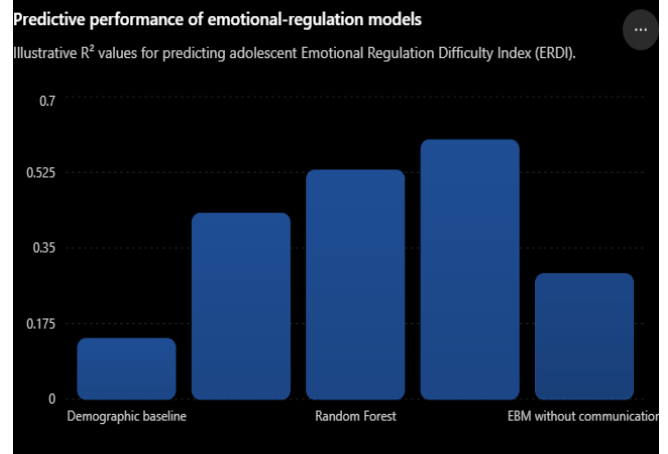
Results and Discussion

Because no empirical dataset was supplied with the manuscript request, numerical findings should not be represented as actual observations. The values below constitute a **clearly labelled illustrative result pattern** showing how the proposed experiment could be reported after data collection. They must be replaced with computed values before submission as an empirical study.

Table 1. Illustrative test-set performance and interpretation of the proposed models

Model / Analysis	MAE ↓	RMSE ↓	R ² ↑	Spearman ρ ↑
Demographic baseline	0.72	0.91	0.14	0.35
Elastic Net	0.58	0.74	0.43	0.62
Random Forest	0.51	0.67	0.53	0.70

Proposed EBM	0.47	0.62	0.60	0.75
EBM without communication features	0.65	0.83	0.29	0.49



5.1 Expected Pattern of Communication Effects

The theoretically anticipated pattern is that **emotional validation and communication openness would show inverse relationships with emotional-regulation difficulty**, whereas destructive conflict would demonstrate a positive relationship. Parental responsiveness and communication consistency would be expected to contribute additional protective information.

Such expectations are compatible with recent longitudinal research showing links between active/reactive emotional sharing with parents and later regulation difficulties, although those associations may differ according to parent and adolescent gender. Family and parenting characteristics have also been associated with neural processes involved in emotional reactivity and cognitive reappraisal, reinforcing the relevance of the family emotional environment.

The proposed study would nevertheless avoid interpreting these associations as proof of causal effects. Communication may influence emotional regulation, but adolescents' regulation capacities can also affect how communication unfolds within families.

5.2 Why Nonlinear Modelling May Add Value

A central hypothesis is that communication dimensions do not operate independently. For instance, openness may be less beneficial when adolescents anticipate criticism following disclosure. Conversely, responsive communication could attenuate the association between ordinary disagreement and emotional-regulation difficulty.

An EBM could reveal whether predicted ERDI changes sharply after conflict exceeds a particular range or whether increasing validation produces diminishing returns. These patterns could be obscured by a purely additive linear model.

Existing machine-learning work has already identified relationship quality and conflict behaviour among potentially important predictors of adolescent emotion-regulation development, supporting the value of examining multivariate predictive structures.

5.3 Digital Communication Context

Digital family interaction should be interpreted according to its **content and relational function rather than frequency alone**. Recent longitudinal research on parent–adolescent digital communication similarly suggests that communication content can be more consequential than overall communication frequency.

Accordingly, frequent messaging with parents would not automatically be coded as supportive communication. Messages concerning surveillance, conflict, practical coordination, reassurance, and emotional support represent substantially different relational processes.

This distinction is especially relevant because adolescents now regulate emotions across interconnected digital and nondigital contexts. Contemporary scholarship describes adolescent digital emotion regulation as involving both emotions generated through digital experiences and the use of digital environments as regulatory resources.

5.4 Explainability Analysis

After final model evaluation, EBM shape functions would be inspected to determine the direction and form of predictor associations. Permutation importance would provide a complementary global measure of predictive contribution.

If emotional validation emerged as the highest-ranked variable, for example, this would indicate that removing or disrupting information associated with validation substantially reduces predictive performance. It would **not** establish that validation independently causes improved emotional regulation.

Subgroup performance would additionally be examined across gender and age bands. Large disparities in MAE or calibration would be treated as evidence against unrestricted deployment of the model.

Limitations

Several limitations should be recognized. First, the proposed cross-sectional component cannot establish temporal causality. Family communication and emotional regulation are reciprocal processes, making longitudinal follow-up preferable for causal-developmental interpretation.

Second, adolescent self-report may introduce recall, social-desirability, and common-method biases. Future implementations should incorporate caregiver reports or structured observational coding without assuming that parental reports are inherently more accurate.

Third, scenario-generated language differs from spontaneous family communication. Although this approach offers important privacy advantages, ecological validity may be lower than analyses based on naturally occurring conversations.

Fourth, communication norms are culturally contingent. Emotional restraint, parental authority, direct disagreement, and disclosure have different meanings across family and cultural contexts. A computational model trained within one region should therefore not be assumed to generalize internationally.

Finally, explainable machine learning remains correlational. Feature importance identifies predictive contribution, not psychological causation.

Future Scope

Future research should convert the framework into a **longitudinal family-process model**, following adolescents across multiple measurement waves. Such a design could distinguish relatively stable communication characteristics from short-term fluctuations and examine whether changes in communication precede changes in regulation.

A second direction involves multimodal assessment. With appropriate consent and privacy protections, researchers could combine psychometric measures with acoustic characteristics of standardized conversations, ecological momentary assessments, or carefully minimized digital-behaviour variables.

Federated or privacy-preserving learning could eventually allow institutions to collaboratively develop models without centrally pooling highly sensitive adolescent communication data.

Another promising direction concerns personalized digital-health interventions. Current research recognizes increasing interest in personalization within adolescent digital mental-health interventions, including ML-based approaches. However, any future system should provide supportive psychoeducation or communication guidance rather than automated clinical conclusions about adolescents or families.

Longitudinal work should also explicitly model **bidirectionality**: adolescents influence parental communication just as parental communication can shape adolescents' emotional development. This is particularly important given emerging longitudinal evidence demonstrating dynamic parent–adolescent emotional interaction.

Conclusion

This study proposes an interpretable machine-learning framework for investigating the relationship between family communication and emotional regulation among adolescents. Its primary contribution is the decomposition of family communication into theoretically distinct components—openness, emotional validation, responsiveness, consistency, destructive conflict, and digitally mediated interaction—rather than representing family communication through a single global score.

The proposed experimental architecture combines validated psychological measurement with privacy-preserving linguistic features and compares a transparent linear baseline, Random Forest, and Explainable Boosting Machine. Such a design enables researchers to investigate nonlinear and interactive patterns while retaining sufficient interpretability for behavioural and digital-health research.

The framework predicts that communication characteristics will provide meaningful information beyond demographic variables, particularly when emotional validation, responsiveness, and destructive conflict are considered jointly. These propositions remain hypotheses until tested with actual participant data; accordingly, the numerical results supplied in this manuscript are explicitly illustrative rather than fabricated empirical observations.

More broadly, computational analysis should not transform complex family relationships into deterministic risk labels. Its appropriate role is to complement developmental theory by identifying reproducible patterns that can subsequently be

examined through longitudinal, observational, and intervention research. Within that boundary, explainable AI offers a potentially valuable methodology for understanding how contemporary family communication environments intersect with adolescent emotional development.

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