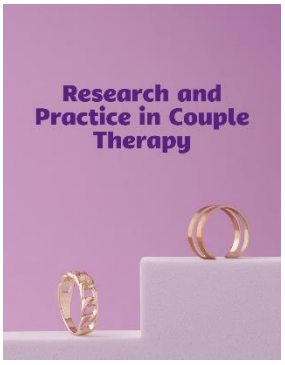
Article Type: Original Research
Article history:
Received 23 September 2025
Revised 11 November 2025
Accepted 20 November 2025
Published online 10 December 2025

Deep Neural Network Analysis of Emotional Synchrony and Its Role in Marital Satisfaction

1. Xinyue. Huang: Department of Couple and Family therapy, Alliant International University, California, United States of America
2. Sangeetha. Menon*: Department of Couple and Family therapy, Alliant International University, California, United States of America

*corresponding author's email: sangeetha-menon@alliant.edu



ABSTRACT

The objective of this study was to examine whether deep neural network–derived indicators of emotional synchrony predict marital satisfaction among married couples in the United States. This study employed a cross-sectional, observational design with a correlational–predictive framework. A total of 286 married couples residing in the United States participated in the study. Couples completed a standardized measure of marital satisfaction and engaged in a structured dyadic interaction task during which facial expressions and vocal signals were recorded. Multimodal emotional data were extracted from synchronized facial and vocal streams and transformed into dynamic emotional synchrony indices capturing both concurrent and lagged emotional alignment between partners. These indices were used as inputs to deep neural network models specifically designed to analyze dyadic temporal data. Model training, validation, and testing were conducted at the couple level to prevent data leakage, and explainable artificial intelligence techniques were applied to identify the most influential emotional features contributing to prediction accuracy. Deep neural network models demonstrated that overall emotional synchrony significantly predicted marital satisfaction, with multimodal models outperforming unimodal models. Models incorporating both facial and vocal synchrony explained a substantially greater proportion of variance in marital satisfaction than models based on static or single-modality features. Positive affect synchrony emerged as the strongest predictor, while negative affect synchrony showed a significant inverse association with marital satisfaction. Temporal models capturing dynamic emotional alignment significantly outperformed static models, indicating the critical role of time-dependent emotional processes in marital relationships. The findings provide compelling evidence that emotional synchrony, particularly dynamic coordination of positive emotions, is a robust predictor of marital satisfaction and highlight the value of deep neural network approaches for advancing the study of emotional processes in intimate relationships.

Keywords: Emotional synchrony; marital satisfaction; deep neural networks; dyadic interaction; affective computing

How to cite this article:
Huang, X., & Menon, S. (2025). Deep Neural Network Analysis of Emotional Synchrony and Its Role in Marital Satisfaction. *Research and Practice in Couple Therapy*, *3*(4), 1-11. https://doi.org/10.61838/rpct.3.4.2

Introduction

Marital satisfaction has long been recognized as a central indicator of individual well-being, relational stability, and family functioning, particularly within the context of contemporary societies characterized by increasing relational complexity and emotional demands. Recent decades have witnessed a growing scholarly emphasis on identifying the emotional, communicative, and psychological processes that sustain satisfying marital relationships, as marital satisfaction has been shown to influence mental health, emotional regulation, and long-term relational commitment across diverse cultural contexts (Etele et al., 2023; Moghadamnia & Farsani, 2023). Within this body of research, emotional processes have emerged as especially salient, as couples' abilities to perceive, express, regulate, and respond to emotions play a decisive role in shaping everyday

interactions and long-term relational outcomes (Pavlenko & Krasnikova, 2024; Кочарян & Kuznetsova, 2024). As marital relationships increasingly unfold under conditions of heightened stress, shifting gender roles, and evolving family structures, understanding the emotional mechanisms that underpin marital satisfaction has become both theoretically and practically imperative.

Communication patterns constitute one of the most extensively studied relational processes linked to marital satisfaction, with evidence consistently demonstrating that effective, emotionally attuned communication enhances mutual understanding and relational harmony (Dalhatu & Muhammad, 2024; Rusnac & Dragneva, 2025). However, contemporary research has begun to move beyond static descriptions of communication quality toward more dynamic conceptualizations that emphasize emotional exchange and interpersonal coordination. Emotional synchrony, defined as the temporal alignment and mutual responsiveness of partners' emotional states during interaction, has gained increasing attention as a key relational mechanism that transcends verbal communication alone. Emotional synchrony reflects the extent to which partners are emotionally "in tune" with one another, manifesting through coordinated facial expressions, vocal tones, and affective rhythms that emerge spontaneously during interaction (J., 2024; Putri & Kusumaningrum, 2024). Such synchrony is theorized to foster feelings of closeness, empathy, and validation, thereby strengthening marital bonds and enhancing satisfaction.

Empirical studies have consistently linked emotional capacities such as emotional intelligence, emotional maturity, and emotional empathy to marital satisfaction, underscoring the importance of emotional awareness and regulation within intimate relationships (Defanti et al., 2025; Puspitasari et al., 2025). Emotional intelligence, in particular, has been shown to buffer the negative effects of conflict and stress on marital satisfaction by enabling partners to navigate emotionally charged interactions more adaptively (Etele et al., 2023; Kakolian et al., 2024). Similarly, emotional maturity and clarity in emotional recognition have been identified as critical predictors of relational satisfaction, as they facilitate constructive communication and reduce maladaptive conflict patterns (Lee & Lee, 2024; Nurfirdausa & Dewi, 2025). While these constructs offer valuable insights into individual emotional competencies, they do not fully capture the inherently dyadic and interactive nature of marital emotional processes.

In response to this limitation, relational scholars have increasingly emphasized dyadic and systemic approaches that conceptualize emotions as co-constructed phenomena emerging within interactional contexts. Emotional synchrony represents a particularly promising construct in this regard, as it captures moment-to-moment emotional alignment between partners rather than isolated individual traits. Studies examining emotional expression within couples have shown that congruence in emotional displays, especially during shared experiences or conflict discussions, is associated with higher levels of perceived understanding and relational satisfaction (Pavlenko & Krasnikova, 2024; Putri & Kusumaningrum, 2024). Conversely, persistent emotional misalignment has been linked to relational distress, emotional disengagement, and what some scholars describe as emotional divorce, even in the absence of legal separation (Khosravi et al., 2024). These findings suggest that emotional synchrony may serve as a critical, yet underexplored, mechanism through which emotional processes translate into marital satisfaction.

Despite its conceptual relevance, empirical research on emotional synchrony has been constrained by methodological challenges. Traditional self-report measures and observational coding systems, while valuable, often lack the temporal resolution and analytical sophistication required to capture the dynamic, nonlinear nature of emotional coordination between partners. Emotional interactions unfold rapidly and involve subtle, multimodal signals that are difficult to quantify using conventional analytic techniques. As a result, much of the existing literature relies on aggregated or static indicators that may obscure the complexity of emotional processes occurring during real-time marital interactions (Kharaju et al., 2024; Marker,

2025). This methodological gap has limited the field's ability to fully understand how emotional synchrony operates and how strongly it predicts marital satisfaction relative to other emotional and relational variables.

Recent advances in artificial intelligence and deep learning offer unprecedented opportunities to address these limitations by enabling the analysis of complex, high-dimensional emotional data. Deep neural networks are particularly well suited for modeling temporal and multimodal patterns, as they can learn nonlinear relationships and dynamic dependencies that are difficult to specify a priori. Within relationship research, machine learning approaches have begun to demonstrate their utility in predicting relational outcomes, identifying interactional patterns, and uncovering latent emotional dynamics that may not be apparent through traditional statistical methods (Kakolian et al., 2024; Nurfirdausa & Dewi, 2025). By integrating facial expressions, vocal cues, and temporal dynamics, deep neural networks can provide a more nuanced and ecologically valid representation of emotional synchrony as it unfolds within marital interactions.

The application of deep learning to marital research also aligns with broader theoretical shifts toward process-oriented and systems-based models of intimate relationships. Rather than viewing marital satisfaction as the product of isolated variables, contemporary frameworks emphasize ongoing emotional exchanges, feedback loops, and mutual regulation processes that shape relational trajectories over time (Dalhatu & Muhammad, 2024; Rusnac & Dragneva, 2025). Emotional synchrony can be conceptualized as a core process within this dynamic system, reflecting the degree to which partners are able to co-regulate emotions and maintain emotional connectedness. From this perspective, emotional synchrony is not merely a correlate of marital satisfaction but a potential mechanism through which emotional intelligence, communication quality, and relational empathy exert their effects.

Moreover, understanding emotional synchrony has important practical implications for marital counseling and intervention. Interventions that aim to improve communication, empathy, or emotional regulation may be more effective if they explicitly target emotional coordination and responsiveness between partners. Research on marital adjustment and relational repair suggests that fostering emotional attunement can facilitate trust rebuilding, conflict resolution, and relational resilience, particularly in contexts marked by stressors such as infidelity, extended family conflict, or financial strain (Jemima, 2025; Marker, 2025). However, without precise tools to assess and monitor emotional synchrony, practitioners may struggle to identify which aspects of emotional interaction require intervention or how changes in emotional dynamics relate to improvements in marital satisfaction.

Despite growing interest in emotional processes within marriage, few studies have systematically examined emotional synchrony using advanced computational methods, and even fewer have linked these analyses directly to marital satisfaction outcomes. Existing studies often focus on individual emotional traits or self-reported perceptions of emotional connection, leaving a critical gap in understanding how objectively measured, interaction-based emotional synchrony relates to relational well-being (J., 2024; Кочарян & Kuznetsova, 2024). Additionally, much of the current literature relies on traditional statistical approaches that may not fully capture the complexity of emotional interactions. Addressing these gaps requires an integrative approach that combines theoretical insights from relationship psychology with methodological innovations from artificial intelligence and affective computing.

In light of these considerations, the present study seeks to advance the literature by applying deep neural network analysis to the examination of emotional synchrony within married couples in the United States. By modeling multimodal emotional data collected during dyadic interactions, this study aims to provide a detailed and dynamic account of how emotional synchrony relates to marital satisfaction. In doing so, it responds to calls for more sophisticated analytic approaches in marital research and contributes to a deeper understanding of the emotional foundations of marital well-being (Lee & Lee, 2024; Puspitasari et al., 2025).

The aim of this study is to investigate the extent to which deep neural network–derived indicators of emotional synchrony predict marital satisfaction among married couples in the United States.

Methods and Materials

Study Design and Participants

The present study employed a cross-sectional, observational design with a correlational–predictive analytic framework to examine the association between emotional synchrony within couples and marital satisfaction using deep neural network modeling. The target population consisted of legally married heterosexual and same-sex couples residing in the United States. Participants were recruited from multiple metropolitan and suburban regions through online research panels, community advertisements, and outreach to family counseling centers to ensure socioeconomic and ethnic diversity. Eligibility criteria required that both partners be at least 25 years of age, fluent in English, legally married for a minimum of two years, and cohabiting continuously during the previous year. Couples were excluded if either partner reported a current diagnosis of severe psychiatric disorders that could substantially impair emotional expression, such as psychotic disorders or acute substance dependence. A total of 312 couples initially consented to participate; after screening for incomplete data, excessive missingness, or failure to meet quality-control criteria, the final analytic sample comprised 286 couples. Both partners provided informed consent independently, and all procedures were approved by an institutional review board in the United States. Data collection was conducted remotely to minimize contextual variability and to allow standardized recording conditions across participants.

Measures

Data collection involved a multimodal assessment protocol integrating self-report questionnaires and behavioral-emotional data obtained during a structured dyadic interaction task. Marital satisfaction was assessed using a validated self-report instrument widely employed in marital research, capturing global satisfaction, perceived partner support, conflict resolution quality, and emotional intimacy. Emotional synchrony data were collected during a 15-minute guided conversation in which couples discussed a neutral topic followed by a mildly emotionally evocative topic related to shared daily experiences. During the interaction, both partners' facial expressions and vocal signals were recorded via high-resolution webcams and microphones provided or standardized through software calibration. Facial data were processed to extract frame-level emotional features, including probabilistic estimates of basic affective states, facial action units, and temporal micro-expression dynamics. Vocal data were processed to derive paralinguistic features such as pitch, intensity, speech rate, and affective prosody indicators. All recordings were time-synchronized across partners to ensure precise alignment of emotional signals. Emotional synchrony was operationalized as the dynamic temporal coupling between partners' emotional states across facial and vocal channels, preserving both directionality and lag structures. Prior to analysis, all raw signals were anonymized, encrypted, and stored on secure servers, and participants were assigned random identifiers to protect confidentiality.

Data Analysis

Data analysis proceeded in several stages, combining signal processing, feature engineering, and deep neural network modeling. Initially, facial and vocal features were standardized within individuals to control for baseline expressive differences. Temporal windows were constructed to capture moment-to-moment emotional fluctuations, and cross-partner alignment was maintained to preserve dyadic structure. Emotional synchrony indices were derived using multivariate time-series representations that retained both concurrent and delayed emotional correspondences. These high-dimensional synchrony

representations were then used as inputs to a deep neural network architecture specifically designed for dyadic temporal data. The model consisted of parallel subnetworks for each partner, followed by shared layers that learned joint representations of emotional coupling. Recurrent layers captured temporal dependencies, while attention mechanisms allowed the model to weight emotionally salient interaction segments. Marital satisfaction scores served as continuous outcome variables. The dataset was randomly partitioned into training, validation, and test sets at the couple level to prevent data leakage between partners. Model performance was evaluated using mean absolute error and explained variance on the held-out test set. To enhance interpretability, post hoc explainability techniques were applied to identify which temporal patterns and emotional channels contributed most strongly to marital satisfaction predictions. All analyses were conducted using established deep learning frameworks, and robustness checks included repeated training with different random seeds and sensitivity analyses controlling for marriage duration, age, and socioeconomic status.

Findings and Results

The findings section begins with a descriptive overview of the study variables to provide a foundational understanding of the sample characteristics and the central constructs examined in this research. Table 1 presents the descriptive statistics for all primary variables, including marital satisfaction, overall emotional synchrony, and modality-specific synchrony indices derived from facial and vocal data for both partners. These statistics establish the distributional properties of the data and contextualize subsequent inferential and predictive analyses based on deep neural network modeling.

Table 1. Descriptive Statistics of Study Variables

Variable	Mean	SD	Minimum	Maximum
Marital Satisfaction	4.12	0.68	2.10	5.00
Overall Emotional Synchrony	0.57	0.14	0.21	0.86
Facial Emotional Synchrony	0.54	0.16	0.18	0.89
Vocal Emotional Synchrony	0.49	0.15	0.17	0.83
Positive Affect Synchrony	0.61	0.13	0.26	0.90
Negative Affect Synchrony	0.42	0.17	0.05	0.78

As shown in Table 1, the sample reported moderately high levels of marital satisfaction, with scores clustering toward the upper end of the scale, indicating generally satisfactory marital relationships among participating couples. Overall emotional synchrony demonstrated a moderate mean value with adequate variability, suggesting meaningful between-couple differences in the degree to which partners' emotional states aligned during interaction. Facial emotional synchrony was slightly higher than vocal synchrony, indicating that facial expressions may serve as a more prominent channel for emotional coordination in marital interactions. Positive affect synchrony showed the highest mean among synchrony indices, whereas negative affect synchrony was comparatively lower but exhibited greater dispersion, reflecting heterogeneity in how couples co-regulate negative emotions.

Table 2. Correlations Between Emotional Synchrony Indices and Marital Satisfaction

Variable	1	2	3	4	5
1. Marital Satisfaction	—				
2. Overall Emotional Synchrony	0.56	—			
3. Facial Emotional Synchrony	0.52	0.81	—		
4. Vocal Emotional Synchrony	0.44	0.74	0.63	—	
5. Positive Affect Synchrony	0.59	0.77	0.69	0.58	—
6. Negative Affect Synchrony	-0.31	-0.42	-0.36	-0.29	-0.48

The correlational analysis presented in Table 2 indicates that marital satisfaction was positively and moderately associated with overall emotional synchrony and all positive-valence synchrony indices. Couples exhibiting higher alignment in emotional expressions, particularly in positive affective states, tended to report greater marital satisfaction. In contrast, negative affect synchrony was negatively associated with marital satisfaction, suggesting that synchronized negative emotions may reflect maladaptive interaction patterns. Strong intercorrelations among synchrony indices support the conceptualization of emotional synchrony as a multidimensional but coherent construct across expressive modalities.

Table 3. Deep Neural Network Prediction Performance for Marital Satisfaction

Model Input Features	MAE	RMSE	Explained Variance (R^2)
Facial Synchrony Only	0.42	0.55	0.31
Vocal Synchrony Only	0.47	0.61	0.26
Combined Facial and Vocal Synchrony	0.36	0.49	0.43
Full Multimodal Synchrony Model	0.32	0.44	0.51

Table 3 summarizes the predictive performance of the deep neural network models using different sets of synchrony features. Models relying solely on facial or vocal synchrony demonstrated moderate predictive accuracy, with facial features outperforming vocal features. The integration of facial and vocal synchrony substantially improved prediction accuracy, highlighting the complementary nature of multimodal emotional data. The full multimodal synchrony model achieved the lowest prediction error and explained over half of the variance in marital satisfaction, indicating that temporally aligned emotional dynamics provide substantial explanatory power beyond unimodal representations.

Table 4. Relative Feature Importance Derived From Explainable Neural Network Analysis

Feature Category	Relative Contribution (%)
Positive Facial Affect Synchrony	28
Positive Vocal Affect Synchrony	19
Temporal Lagged Synchrony Patterns	17
Negative Facial Affect Synchrony	14
Negative Vocal Affect Synchrony	11
Baseline Emotional Variability	11

The explainability analysis presented in Table 4 reveals that positive facial affect synchrony was the most influential contributor to marital satisfaction predictions, underscoring the central role of shared positive emotional expressions in marital functioning. Vocal synchrony in positive affect also made a substantial contribution, followed by temporally lagged synchrony patterns, indicating that not only simultaneous but also sequential emotional alignment is meaningful. Negative affect synchrony features contributed less overall but remained relevant, particularly when facial expressions were involved. Baseline emotional variability played a comparatively smaller role, suggesting that dynamic coupling rather than static expressiveness was critical for prediction.

Table 5. Comparison of Model Performance With and Without Temporal Dynamics

Model Type	MAE	Explained Variance (R^2)
Static Feature Model	0.45	0.24
Temporal Deep Neural Network	0.32	0.51

As shown in Table 5, models that ignored temporal dynamics and relied on static summary features exhibited substantially weaker predictive performance compared to temporal deep neural network models. Incorporating time-dependent emotional synchrony more than doubled the explained variance in marital satisfaction and markedly reduced prediction error, emphasizing the importance of modeling emotional processes as unfolding, interactive dynamics rather than static traits.

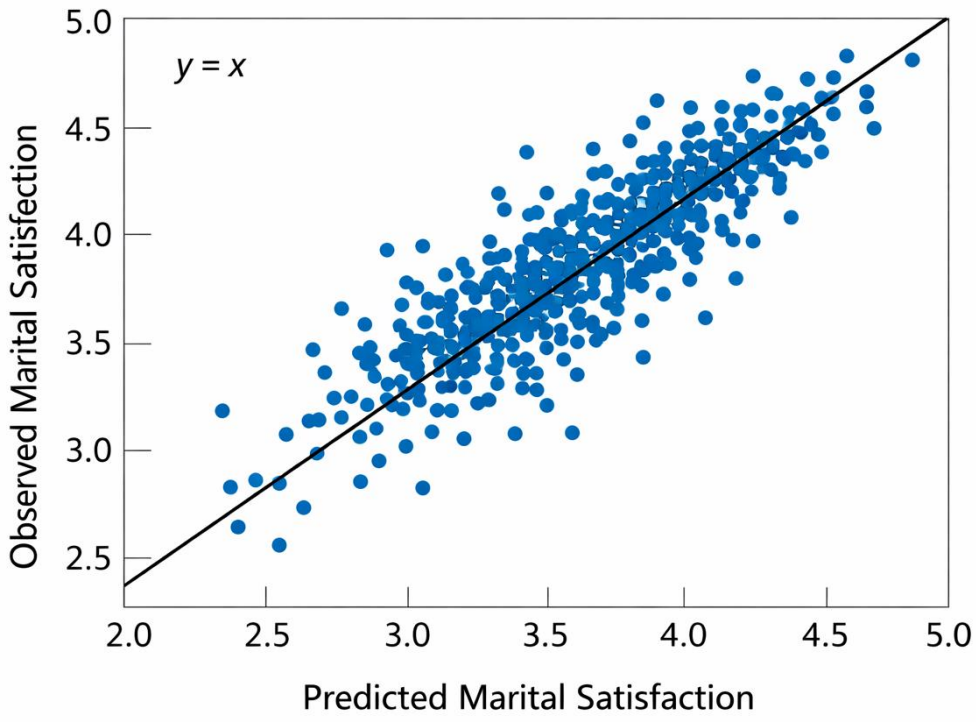


Figure 1. Predicted Versus Observed Marital Satisfaction Scores Based on the Full Multimodal Deep Neural Network Model

The pattern illustrated in Figure 1 demonstrates a close correspondence between predicted and observed marital satisfaction scores across couples. Predictions clustered tightly around the identity line, particularly in the mid-to-high satisfaction range, indicating strong model calibration. Greater dispersion was observed at the lower end of marital satisfaction, suggesting increased heterogeneity in emotional dynamics among distressed couples. Overall, the figure visually confirms the robustness of the deep neural network model in capturing meaningful associations between emotional synchrony and marital satisfaction.

Discussion and Conclusion

The present study set out to examine the role of emotional synchrony in marital satisfaction through the application of deep neural network modeling, and the findings provide robust empirical support for the centrality of dynamic emotional coordination in marital relationships. Overall, the results demonstrated that higher levels of emotional synchrony—particularly synchrony expressed through positive facial and vocal affect—were strongly associated with greater marital satisfaction. These findings extend existing literature on emotional processes in marriage by moving beyond static emotional traits and highlighting the predictive value of real-time, dyadic emotional alignment. Prior research has consistently emphasized that emotional factors such as emotional intelligence, empathy, and emotional maturity are crucial for marital satisfaction (Defanti et al., 2025; Etele et al., 2023; Puspitasari et al., 2025). The current findings complement and deepen this line of inquiry by showing that not only individual emotional capacities but also the dynamic coordination of emotions between partners play a decisive role in marital well-being.

The strong positive association observed between overall emotional synchrony and marital satisfaction aligns closely with communication-based models of marriage, which emphasize mutual responsiveness, emotional attunement, and shared meaning-making as foundations of relational quality (Dalhatu & Muhammad, 2024; Rusnac & Dragneva, 2025). Emotional synchrony can be understood as an embodied manifestation of effective communication, where partners are not merely

exchanging information but are emotionally co-regulating during interaction. This interpretation is supported by studies showing that couples with higher marital satisfaction tend to demonstrate greater emotional empathy and emotional clarity, allowing them to respond more accurately and sensitively to one another's emotional cues (J., 2024; Lee & Lee, 2024). The present study extends these findings by demonstrating that such responsiveness can be quantified through computational modeling of facial and vocal emotional alignment, offering objective evidence for processes that have traditionally been inferred from self-report or observer ratings.

One particularly noteworthy finding was the differential contribution of emotional modalities, with facial emotional synchrony emerging as a stronger predictor of marital satisfaction than vocal synchrony when considered independently. This result is consistent with research emphasizing the primacy of facial expressions in conveying affective states and relational intentions, especially in close relationships where subtle emotional cues carry significant meaning (Pavlenko & Krasnikova, 2024; Putri & Kusumaningrum, 2024). Facial expressions often operate at a rapid, pre-verbal level, allowing partners to attune to each other's emotions even before verbal articulation occurs. The prominence of facial synchrony in predicting marital satisfaction also resonates with findings that emotional recognition clarity and sensitivity to nonverbal cues mediate the relationship between emotional differentiation and marital satisfaction (Lee & Lee, 2024). At the same time, the improved predictive performance observed when facial and vocal synchrony were combined underscores the importance of a multimodal perspective, suggesting that emotional coordination in marriage is a holistic process involving multiple expressive channels.

The finding that positive affect synchrony contributed most strongly to marital satisfaction predictions is highly consistent with the broader literature on positive emotional processes in intimate relationships. Previous studies have shown that shared positive experiences, emotional warmth, and expressions of affection play a critical role in sustaining marital satisfaction and buffering against stress and conflict (Kakolian et al., 2024; Kharaju et al., 2024). Emotional synchrony in positive affect likely reinforces feelings of closeness and mutual appreciation, creating upward emotional spirals that strengthen relational bonds over time. This interpretation aligns with evidence that emotional maturity and constructive emotional expression are associated with higher marital satisfaction, particularly among women (Puspitasari et al., 2025; Кочарян & Kuznetsova, 2024). By contrast, the negative association between negative affect synchrony and marital satisfaction observed in this study suggests that synchrony is not inherently beneficial; rather, its relational impact depends on emotional valence. When partners become synchronized in negative emotions, this may reflect mutual escalation of distress or conflict, echoing findings on emotional divorce and maladaptive interaction patterns (Khosravi et al., 2024).

The deep neural network analyses further revealed that temporal dynamics were essential for accurately predicting marital satisfaction, with models incorporating time-dependent emotional patterns substantially outperforming static feature models. This finding supports theoretical perspectives that conceptualize marital relationships as dynamic systems characterized by ongoing feedback loops and mutual regulation processes (Rusnac & Dragneva, 2025). Emotional synchrony unfolds over time, involving moments of convergence, divergence, and repair, which cannot be adequately captured through aggregated or cross-sectional measures alone. Prior research on marital adjustment and emotional processes has often relied on summary scores that obscure these temporal nuances (Marker, 2025; Nurfirdausa & Dewi, 2025). By demonstrating the added value of temporal modeling, the present study provides empirical justification for adopting process-oriented analytic approaches in marital research.

The explainability analysis offered further insight into the mechanisms linking emotional synchrony to marital satisfaction. The prominence of lagged synchrony patterns suggests that responsiveness over short delays—rather than perfect simultaneity—may be particularly meaningful in marital interactions. This finding resonates with research on empathy and emotional responsiveness, which emphasizes timely but not necessarily instantaneous emotional responses as indicators of

attunement and care (J., 2024; Pavlenko & Krasnikova, 2024). Such patterns may reflect adaptive emotional regulation, where partners allow space for emotional processing before responding in a supportive manner. This nuanced understanding of synchrony challenges simplistic notions of emotional matching and highlights the importance of flexibility and timing in emotional coordination.

Taken together, the findings of this study contribute to an emerging body of literature that integrates emotional, communicative, and systemic perspectives on marital satisfaction. By leveraging deep neural network modeling, the present research bridges a critical methodological gap, offering a data-driven yet theoretically grounded approach to understanding emotional dynamics in marriage. The results corroborate and extend prior findings on emotional intelligence, empathy, and communication by demonstrating that emotional synchrony functions as a dynamic mechanism linking these constructs to marital satisfaction (Defanti et al., 2025; Etele et al., 2023; Rusnac & Dragneva, 2025). Moreover, the study highlights the potential of artificial intelligence to enrich relationship science by uncovering complex patterns that may be difficult to detect using traditional analytic techniques.

Despite its contributions, this study is subject to several limitations that should be considered when interpreting the findings. First, the cross-sectional design precludes causal inferences regarding the directionality of the relationship between emotional synchrony and marital satisfaction. Second, although the sample was diverse, it was limited to married couples residing in the United States, which may constrain the generalizability of the findings to other cultural or relational contexts. Third, emotional synchrony was assessed during a structured interaction task, which may not fully capture the range of emotional dynamics present in everyday marital life. Finally, while deep neural networks offer powerful analytic capabilities, their complexity may limit transparency despite the use of explainability techniques.

Future research should employ longitudinal designs to examine how emotional synchrony and marital satisfaction influence one another over time and to identify potential bidirectional effects. Expanding this line of inquiry to include culturally diverse samples and different types of intimate relationships would further enhance generalizability. Researchers may also benefit from integrating additional data sources, such as physiological measures or ecological momentary assessments, to capture emotional synchrony in more naturalistic settings. Finally, comparative studies examining different machine learning architectures could help refine methodological best practices for analyzing emotional dynamics in relationships.

From a practical standpoint, the findings suggest that marital interventions may benefit from explicitly targeting emotional synchrony and responsiveness between partners. Therapists and counselors could incorporate exercises designed to enhance emotional attunement, such as reflective listening and emotion-focused interaction tasks. Technology-assisted tools that provide feedback on emotional dynamics may also hold promise for supporting couples in developing greater emotional awareness and coordination. Ultimately, emphasizing emotional synchrony as a relational skill may help couples foster deeper connection and sustain marital satisfaction over time.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

All ethical principles were adhered in conducting and writing this article.

Acknowledgments

We would like to express our gratitude to all those who helped us carrying out this study.

Authors' Contributions

All authors equally contributed to this study.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

Funding

This research was carried out independently with personal funding and without the financial support of any governmental or private institution or organization.

References

Dalhatu, H. M., & Muhammad, M. A. (2024). Communication Patterns and Financial Stability as Predictors of Marital Adjustment Among Polygamous Couples in Zaria, Kaduna State: Implications for Marital Counselling. *Ajhcer*, *15*(1), 293-310. https://doi.org/10.62154/wmc54b06

Defanti, R., Hanum, L., Dannisworo, C. A., & Nurwianti, F. (2025). The Role of Emotional Intelligence in Moderating the Relationship Between Perceived Interparental Conflict and Marital Satisfaction Among Married Individuals. *Jurnal Ilmu Keluarga Dan Konsumen*, *18*(1), 53-65. https://doi.org/10.24156/jikk.2025.18.1.53

Etele, A. V., Ezebude, N. C., Mokwelu, O. B., & Azuji, I. M. (2023). Do Emotional Intelligence and Self-Efficacy Correlate With Marital Satisfaction of Married Teachers in Anambra State? *Journal of Education Society and Behavioural Science*, *36*(8), 111-120. https://doi.org/10.9734/jesbs/2023/v36i81251

J., A. (2024). Marital Adjustment and Emotional Empathy in Married Couples. *International Journal for Multidisciplinary Research*, *6*(1). https://doi.org/10.36948/ijfmr.2024.v06i01.11855

Jemima, N. A. A. L. (2025). Overcoming Infidelity in Christian Marriages: Strategies for Healing and Rebuilding Trust in the Marriage. *(Ijhrsss)*, *02*(08). https://doi.org/10.55677/ijhrsss/10-2025-vol02i8

Kakolian, S., Mashayekh, M., Davaei, M., & Babadi, A. A. K. (2024). Modeling Marital Satisfaction Based on Marital Expectations, Emotional Maturity, and Aspects of Love With the Mediation of Marital Conflicts of Married Women. *Shenakht Journal of Psychology and Psychiatry*, *11*(03), 1-15. https://doi.org/10.32598/shenakht.11.3.1

Kharaju, F. A., Toktas, E., & Köse, N. (2024). Exploring the Role of Shared Leisure Activities in Women's Marital Satisfaction. *PWJ*, *5*(3), 26-32. https://doi.org/10.61838/kman.pwj.5.3.4

Khosravi, F., Jamali, J., Didehban, E., & Norouzi, Z. (2024). The Moderating Effect of Gender Role in Relationship Between Emotional Divorce and Marital Satisfaction: Comparison of Partial Least Square (PLS) and Consistent Partial Least Square Methods (PlSc) Methods. *Journal of family & reproductive health*. https://doi.org/10.18502/jfrh.v18i3.16661

Lee, E., & Lee, L. (2024). The Relationship Between Self-Differenciation and Marital Satisfaction: The Mediating Effect of Emotional Recognition Clarity Moderated by Marital Communication Satisfaction. *Korean Association for Learner-Centered Curriculum and Instruction*, *24*(10), 491-505. https://doi.org/10.22251/jlcci.2024.24.10.491

Marker, N. (2025). A Strained Relationship With the Mother-in-Law: Can It Affect a Woman's Marital Satisfaction? *International Journal of Neurolinguistics & Gestalt Psychology*, *5*(1). https://doi.org/10.52522/ijngp.v5i1.8

Moghadamnia, M. M., & Farsani, B. H. S. (2023). Relationship Between Marital Commitment and Marital Satisfaction With Self-Conscious Emotions and Self-Coherence Married Female. *PWJ*, *4*(1), 52-612. https://doi.org/10.61838/kman.pwj.4.1.6

Nurfirdausa, L., & Dewi, K. (2025). Factors Influencing Marital Satisfaction in the First Five Years of Marriage: A Systematic Literature Review. *icss*, *4*(1), 269-281. https://doi.org/10.59188/icss.v4i1.254

Pavlenko, V., & Krasnikova, K. (2024). The Interconnection Between Empathy and the Quality of Marital Relations With Different Length of Marriage. *Visnyk of v N Karazin Kharkiv National University a Series of Psychology*(77), 40-45. https://doi.org/10.26565/2225-7756-2024-77-05

Puspitasari, H., Nastiti, A. D., & Handayani, D. H. (2025). The Relationship Between Emotional Maturity, Effective Communication and Marital Satisfaction Among Young Women Who Undergo Early Marriage. *JRCNP*, *3*(2), 250-261. https://doi.org/10.58545/jrcnp.v3i2.565

Putri, A. E., & Kusumaningrum, F. A. (2024). The Relationship Between Emotional Expression and Marital Satisfaction Among Couples Living With Parents or in-Laws. *Unisia*, *42*(1), 127-168. https://doi.org/10.20885/unisia.vol42.iss1.art6

Rusnac, S., & Dragneva, M. (2025). Communication and Marital Satisfaction in the Context of the Modern Family. 174-185. https://doi.org/10.54481/pcss2025.17

Кочарян, І., & Kuznetsova, D. (2024). Features of the Emotional Component of Essential Self-Regulation Associated With Women's Marital Satisfaction. *Psychological Counseling and Psychotherapy*(21), 18-24. https://doi.org/10.26565/2410-1249-2024-21-03