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RESEARCH

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Dynamic harmony: Unveiling therapeutic attunement in emotionally focused couples therapy via machine learning

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Abstract

Objective: The goals of the study were to examine therapists' and clients' emotional states and expressions in an emotionally focused therapy (EFT) couple session, to assess therapeutic attunement between the clients and the therapist, and to explore its alignment with EFT techniques.

Background: Therapeutic attunement is crucial for fostering a therapeutic alliance in couples therapy, yet examining triadic relationships between therapist and partners is methodologically challenging. This case study introduces a novel computational social science approach to capture attunement in an EFT session.

Method: A full-length, publicly available EFT session video was analyzed. We generated text, audio, and image data for computerized tracking and conducted a multimodal analysis of emotions using mixture of experts machine learning models.

Results: Seven emotion states were analyzed: anger, fear, surprise, disgust, joy, sadness, and neutral. The results indicated a close alignment between the couple and the therapist's emotions, suggesting high attunement. Three types of attunement by timing were identified: on time, therapist initiated, and delayed. Attunement peaks aligned with EFT techniques.

Conclusion: High levels of therapeutic attunement, facilitated by EFT techniques, can be effectively captured and analyzed using machine learning.

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Implications: This study highlights the feasibility of using machine learning to track attunement dynamics and aids therapists in exploring therapeutic ruptures.

KEYWORDS

attunement, couples therapy, emotionally focused therapy, machine learning, the mixture of expert models

INTRODUCTION

Therapeutic attunement (TA), defined as therapists' awareness, tracking, and implicit understanding of changes in the emotional and somatic states of the clients, themselves, and their relationship in therapy (Seikkula et al., 2015), plays a key role in the formation of therapeutic alliance and therapist efficacy (Goldman, 2017; Rocco et al., 2017). TA is especially salient in attachment-based interventions and models such as emotionally focused therapy (EFT; Johnson, 2004, 2020). In EFT, the therapist fully engages with the client, tuning in to the client's emotions (Johnson & Greenman, 2006; Stiegler et al., 2018) and paying attention to both verbal and nonverbal cues to understand and respond to the client's immediate experience (Goldman, 2017; Johnson, 2019). In that model, the therapist creates a secure relationship environment, enabling clients to focus inwardly and understand their internal dynamics and interactions with others during therapy (Elliott & Macdonald, 2021).

Therapists need to exhibit a range of skills to foster TA spanning from immediacy, presence, cognitive understanding, and observation to empathy, attentive listening to clients, and understanding their current emotions (Elliott & Macdonald, 2021). However, TA can also be highly challenging because emotions are expressed in various ways—verbal, nonverbal, and sometimes in contradiction with one another such as smiling while crying during the session (dos Santos, 2022; Goldman, 2017; Håvås et al., 2015). Emotions may also be hindered or suppressed, especially when they are intense, and are associated with triggers and cues related to the client's attachment injuries (Johnson, 2004, 2008, 2019). Given those challenges, further research is needed to examine emotions in the therapy process, their association with TA, and specific techniques therapists may use to address them. The current study addresses this need with a particular focus on EFT as a couples therapy model. EFT provides a rich context for exploring TA due to its emphasis on a range of emotions (Johnson, 2004, 2008, 2019), while being manualized and structured enough to map out and match specific skills and TA (Beasley & Ager, 2019; Johnson, 2004, 2019).

Therapeutic attunement

TA is a synchronized, bidirectional, and nonlinear process that develops and evolves throughout the therapy process, where therapists and clients experience and adapt to a diverse range of emotions (Seikkula et al., 2015). Attuned therapists empathetically recognize and understand the client's sensations, feelings, and safety needs, and respond to them with sensitivity, reassurance, and unconditional positive regard (dos Santos, 2022). This process includes providing physical and emotional safety while respecting the client's vulnerability. An attuned therapist makes the client feel understood and validated (dos Santos, 2022; Håvås et al., 2015; Johnson, 2019). A therapist's mirroring of the client is linked to the client's self-criticism (Stiegler et al., 2018) while fostering the growth of a therapeutic relationship over time (Rocco et al., 2017).

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Examining TA in couples therapy is important for fostering a sense of safety and trust between the therapist and the clients. Couples therapy poses a unique challenge for TA because the therapist needs to be empathetic, validating, and attuned to the needs of both partners in the session (Johnson, 2019, 2020). This process, without doubt, is a complex interplay between the therapist and the couple who have different—and sometimes opposing—attachment needs, attachment behaviors, and even therapeutic goals. As such, couples therapy can provide an opportunity to uncover the dynamics of TA with simultaneous consideration of the couple's relational pattern and cycle, and their verbal and nonverbal interactions with one another as well as the therapist. Although prior research has examined TA and its role in the therapy process with individual clients, only limited research has examined TA in the couples therapy context (see Seikkula et al., 2015, as an exception). Yet, there is a scarcity of research that investigates consequent consideration of verbal and nonverbal cues along with the relational pattern of the couple. Nonverbal communication, such as glances, facial expressions, vocal patterns, and postures, is a key aspect of attunement (Rocco et al., 2017). Indeed, verbal attunement alone proved ineffective in fostering TA without the combination of nonverbal attunement (dos Santos, 2022; Håvås et al., 2015) and high nonverbal synchrony ratings between the therapist and the client indicate strong therapeutic relationship quality (dos Santos, 2022; Rocco et al., 2017). Despite its importance, the integration of verbal and nonverbal communication aspects of attunement remains largely unexplored, especially in couples therapy. The current study addresses this gap in the literature by examining TA in couples therapy, more specifically in EFT.

EFT and therapeutic attunement

EFT is an evidence-based attachment- and systemic-oriented therapy model where therapists work with couples to uncover their emotional triggers and core beliefs and help them to understand and reshape their emotions to foster deeper connections and enhance interactions (Johnson, 2019; Seedall & Sandberg, 2020). Given that the EFT focuses on fostering empathy toward one's emotional journey and significant others, empathizing with the other partner and being tuned in to their emotions and attachment needs are crucial (Johnson, 2008, 2019, 2020). Therapists play a pivotal role in this process. By being emotionally present in the session, the therapist observes each partner's position in the relationship and mirrors emotions while providing support and comfort. In doing so, EFT therapists create a safe environment to uncover both partners' attachment needs, attachment behaviors, and injuries while outlining the couple's relationship dynamic (Johnson & Greenman, 2006; Seedall & Sandberg, 2020). That process includes careful processing of primary and secondary emotions and their association with attachment needs and behaviors. Primary emotions are immediate, direct reactions to situations, whereas secondary emotions are responses to these immediate reactions and often mask awareness of the primary response. Emotions are directly related to attachment. For instance, when a partner perceives their attachment figure as inaccessible, intense emotions like fear, anger, and sadness can emerge (Johnson, 2019). Attachment theory posits that when security is threatened, protest and anger are followed by attempts to seek closeness. If these fail, depression and despair can lead to detachment and separation (Johnson, 2004; Johnson & Greenman, 2006; Seedall & Sandberg, 2020).

In EFT, therapists must also consider whether their emotions are attuned to the primary or secondary emotions of the clients. Revealing the attachment needs of couples and maintaining empathetic alignment with clients' emotions requires staying deeply connected to their experience, focusing closely on all dimensions of their experience, and prioritizing attention on their feelings and intentions (Goldman, 2017). Attunement plays a crucial role in that relational dialogue, encompassing empathy, validation, respect, curiosity, and autonomy. This emphasizes

the importance of an open, collaborative dialogue that recognizes both the client's concerns and the therapist's contributions (Elliott & Macdonald, 2021).

To understand how EFT fosters attunement, it is important to understand its structured treatment process. The EFT model consists of several steps categorized into three stages (Johnson, 2004, 2019). Stage 1 involves the de-escalation of negative cycles of interaction. Steps include building an alliance, identifying the negative cycle and the unacknowledged emotions underlying it, and reframing the couple's problems in terms of the cycle, underlying emotions, and attachment needs (Johnson, 2019). By the end of this stage, couples understand the dynamics of their cycle and shift their focus from blaming each other to changing the cycle (Beasley & Ager, 2019; Johnson, 2019). Stage 2 involves transforming the couple's interactional positions and restructuring their emotional connection. Steps include recognizing and accepting disowned attachment needs, fears, and aspects of self, accepting one's partner's experiences, and directly expressing needs through in-session bonding events (Johnson, 2019). Stage 3 involves consolidation and integration, where couples foster healthier interaction patterns, resolve conflicts more effectively, and find new solutions to their interactional challenges. The therapist recognizes the couple's enhanced communication and empathy toward each other (Beasley & Ager, 2019).

Although the goals of each EFT stage vary, TA remains a fundamental element of the therapy process. However, the specific role of TA in these stages, especially in the early stages of the therapy process, remains unexplored. Despite the emphasis on TA in EFT training (Johnson, n.d., Johnson, 2004, 2020), there is a lack of research on emotional expressions throughout the session along with its links to the development of TA. Moreover, therapists, especially those in training, may find it challenging to observe their progress or problems in TA. New technological developments can help therapists improve their attunement by providing tools to track and analyze emotional alignment during sessions. The current study addresses those gaps in research and clinical practice.

Machine learning and psychotherapy

We are currently in a pivotal stage of the fourth industrial age, often referred to as the "digital revolution," identified by the convergence of various technological domains (Graham et al., 2019; Schwab, 2017). Although there are concerns about the use of artificial intelligence (AI) in the field of mental health (i.e., Timmons et al., 2023), its applications are progressively expanding in symptom identification and clinical diagnosis of mental disorders, risk assessment, and treatment processes (Graham et al., 2019). According to the review by Graham et al. (2019), supervised machine learning is the predominant AI technique among AI and mental health studies, with some studies also incorporating natural language processing (NLP; i.e., Bedi et al., 2015). Such techniques have the potential to enable researchers and clinicians to offer personalized and context-sensitive information for both assessment and intervention purposes (Shatte et al., 2019). In recent studies from diverse countries, such as those by Madanian et al. (2022) and Majidi and Bahrami (2023), machine learning-based emotion recognition from speech has shown great potential for enhancing clinical mental health interventions, especially by helping practitioners better understand clients' emotional states through emotion classification.

The concept that our language and vocal expressions can reflect our psychological states, combined with advancements in NLP and audio analysis within AI fields, caused an investigation into the links between language and voice features and mental well-being (D'Alfonso, 2020). These application fields are utilized in mental health classification or predictions (Bedi et al., 2015). Apart from NLP of text, research on using AI to analyze the paralinguistic or acoustic features (such as volume, pitch, and intonation) of speech has revealed the ability to computationally analyze these properties to suggest mental health information (D'Alfonso, 2020).

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Despite those technical advancements in mental health research, the use of AI, and more specifically machine learning, in couples therapy research is still in its early stages. Most of the computational studies with couples in treatment settings are rather methodological such as developing algorithms for emotion recognition in speech. For example, Crangle et al. (2019) analyzed the emotional speech of 18 hours of couples therapy sessions with three different clients and developed a method to code the audio recordings for the four emotions of anger, sadness, joy, and tension, plus neutral. The study demonstrated and compared the accuracy, precision, and fitness of different machine learning models to recognize those emotions in speech during couples therapy. While identification of the best model of emotion recognition is valuable, there is still a need to use computational methodology as a means to understand the therapy process and uncover the dynamic interplay between therapists and couples. Furthermore, examining TA poses challenges for researchers in identifying the precise onset of emotions, especially when relying solely on verbal behavior. Pinpointing the beginning of an emotion and its attuned emotions within milliseconds is difficult, and recognizing emotional onset is even more complex. Additionally, therapy process research becomes more challenging in couples and family therapy with multiple family members in the room, each engaging in unique verbal and nonverbal interactions with the therapist as well as with one another. The nuance and subtlety of emotions expressed in psychotherapy provide a unique view of emotional interchange when two or three people interact (Crangle et al., 2019).

Current study

While it is well established that therapeutic attunement plays a crucial role in fostering therapeutic alliance in couples therapy (Goldman, 2017; Rocco et al., 2017), there are ongoing methodological challenges in examining triadic relationships between the therapist and partners to fully uncover attunement. In addition, emotion recognition in the couples therapy context has been limited to developing new methods to analyze audio recordings and recognize emotions (Crangle et al., 2019), and there is a need for further research that explores how therapists and clients display emotions in couples therapy and how these processes relate to therapy theory and techniques. The current study addresses these gaps by including a broader range of emotions, using a theory-driven approach based on a standardized couples therapy model, and integrating qualitative analysis to provide examples and quotes from the couple's session for the main quantitative findings. As such, our study contributes to the literature by analyzing both verbal and nonverbal emotional expressions of a therapist and clients. Microanalysis of real human interactions in couples therapy has implications for understanding therapy processes and improving clinical practices.

In the current study, we propose a novel computational social science approach, more specifically machine learning (ML; Zucchetti et al., 2024), to capture triadic TA in couples therapy. To that aim, we explore TA within EFT, an evidence-based, attachment-oriented couples therapy model emphasizing deepening emotional engagement (Johnson, 2004, 2019). EFT therapists engage with emotions by reflecting on clients' emotional reactions, validating responses, and posing evocative questions (Johnson & Greenman, 2006). As such, the EFT therapists observe, reflect on, and remain emotionally present and attuned to both partners during sessions, therefore, the rich context of the EFT process allows for an examination of attunement in the therapy process. Using visual, auditory, and textual data of an exemplar EFT session, the objectives of the present study were to (a) explore and track emotional states and expressions of partners and the therapist in a couples therapy session, (b) assess types and trajectories of attunement during the session for each therapist–partner dyad, and (c) identify related EFT techniques that align with each type of TA. Given the descriptive nature of the study, our hypotheses were exploratory. Specifically, we expected that attunement would align with the

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demands and outcomes of EFT techniques, and any time lag in attunement would be elucidated by the dynamics inherent in the therapy process.

METHOD

Sampling and procedure

Sampling and video selection process

We utilized purposive sampling to select a single EFT video for a detailed case study. Purposive sampling involves the deliberate selection of a specific case based on its relevance and capacity to provide rich data aligned with the research objectives. Initially, we identified 17 DVD videos from the International Centre for Excellence in Emotionally Focused Therapy (ICEEFT) website and three live session videos from the university library digital archives. We screened those videos based on the following criteria:

a. Therapist consistency: The video features Sue Johnson, a master therapist in EFT, ensuring a consistent therapeutic style and technique.
b. Completeness: The video captures a complete therapy session from beginning to end, which is essential for comprehensively analyzing the progress of TA throughout the session.
c. Visibility: The video clearly shows the faces of each individual involved in the session and the video has clear voices, enabling the analysis of facial expressions and verbal and nonverbal communication, which are crucial for understanding TA.

Out of the 17 videos we retrieved and screened, we eliminated five videos because they were too short (<30 min). We could not access seven videos in full length, and one additional video was removed because it featured a different therapist than Sue Johnson. The remaining videos ($n = 3$) could not be analyzed due to poor image and sound quality. As a result, we identified and selected one full-length EFT couple session training video that fulfilled all selection criteria. We acquired the video through the ICEEFT website, then downloaded and curated it for preprocessing and further data analysis (as explained below). We obtained official permission from the ICEEFT to examine the expressed emotions in the video. Of note, the study procedures were exempt from institutional review board approval because the video was publicly available, did not contain identifiable private information, and there was no direct interaction with human subjects. That is, our study qualified for exemption from institutional review board review under 45 CFR 46.104(d)(4) (U.S. Department of Health and Human Services, 2018).

Video content

The selected video is a 60-minute EFT session with a 30-year-old heterosexual, immigrant, married couple where the woman is distressed by a traumatic migration history and presents symptoms of depression. In this session, Dr. Sue Johnson demonstrates EFT Stage 1, specifically Steps 3, 4, and 5. During the session, she gathers information about the couple and outlines their relationship dynamic. In the training segments of the video (presession and postsession discussion), Dr. Sue Johnson conceptualizes the case by emphasizing the couple's pursuer–withdrawer dynamic where the woman seeks closeness and connection as a pursuer while the man withdraws, feeling like a failure and stuck in uncertainty. Next, she demonstrates how couples can empathetically understand each other's attachment behaviors and needs.

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Data preparation: Extraction and preprocessing

Figure 1 illustrates the multimodal system architecture with details of data extraction (Step 1) and preprocessing (Steps 2 and 3). The system begins by capturing session video and extracting the corresponding audio and image frames (Step 1). The session audio serves as the input for both the speech-to-text ML model and the speaker recognition and diarization ML model. The speech-to-text model converts the spoken language in the audio into a textual transcript, while the speaker recognition model identifies different speakers and marks their speaking time intervals (Steps 2a and 2b). The generated transcript undergoes text processing to produce a "trialogue," a conversation transcript involving three people in the session. This process also involves cleaning the text, partition, and context extraction to prepare it for subsequent analysis (Step 3a). Concurrently, the session audio, along with the speaker time stamps, is segmented into smaller windows or utterances through the audio windowing process. This segmentation facilitates detailed analysis by breaking down the audio into manageable segments based on the speaker's identified time intervals (Steps 2b and 3b). In parallel, the system processes session images extracted from the video. The face recognition ML model detects faces in these images and outputs bounding boxes around each face (Step 2c). These bounding boxes are then cropped and resized to create individual face images for facial expression analysis (Step 3c).

Data analysis

Summary of the analysis

The data analysis process involved a multimethod, mixed-design approach that integrated computational, quantitative, and qualitative analysis. First, we used computational methodology to examine the multimodal inputs (text, audio, and image data). Steps 4 and 5 of Figure 1 illustrate that process. The computational analysis allowed us to generate scores of basic emotions for each individual in the session across time as well as attunement scores for therapist–withdrawer (male partner) and therapist–pursuer (female partner) dyads for each emotion. Second, we ran a descriptive statistical analysis of emotion states and attunement scores (quantitative analysis). Finally, we identified the peak points for attunement in the session, watched the time stamped segment of the video, and performed a content analysis of this segment to

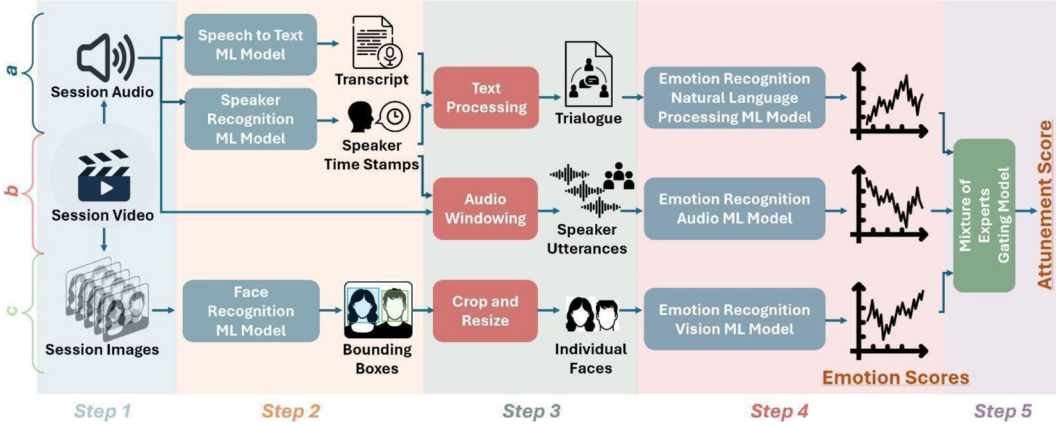

FIGURE 1 System architecture for multimodal emotion recognition and attunement. [Color figure can be viewed at wileyonlinelibrary.com]

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examine its alignment with the EFT model and related techniques (qualitative analysis). Details of each data analysis step are explained more in detail below. We used Python and PyTorch for computational and quantitative analysis in the current study.

Computational analysis

Emotion recognition of text, audio, and image data and generation of emotion scores
Following the preprocessing, we ran three distinct emotion recognition ML models for each modality (Step 4) and we used pretrained ML models in that analysis. All pretrained ML models we selected were based on large training sets of digital data that demonstrated high accuracy and precision in recognition of Ekman et al.'s (1972) six basic emotions (anger, joy, shame, fear, sadness, surprise) plus a neutral class in prior studies (see supplemental materials for details). Specifically, we used the pretrained DistilledRoBERTa (Hartmann, 2022) for textual emotion recognition. We analyzed the processed text (trialogue) via the emotion recognition NLP model to determine the emotional state. In parallel, the emotion recognition audio model examined the speaker's utterances for emotion recognition based on vocal tone, pitch, and other auditory features. We employed the Meta AI team's fine-tuned version of wav2vec2.0 (Baevski et al., 2020; Lan, 2023) as a pretrained model for audio emotion recognition. Finally, for the emotion recognition vision model, we used the vision transformer (Dosovitskiy et al., 2020) model and processed the session images extracted from the video to identify emotions through facial expression analysis. These emotion recognition models at Step 4 of the architecture (Figure 1) generated emotion scores for further analysis. This allowed us to have seven emotion scores for each individual in the video (male partner, female partner, the therapist) with time stamps across time.

Integration of multimodal emotion scores and generation of attunement scores for dyads
Emotion scores from the NLP, audio, and vision model were integrated using the mixture of experts (MoE; Shazeer et al., 2017) ML model. The MoE ML model is a machine learning technique that enables continuous time series predictions for multiple individuals, allowing for real-time monitoring of emotional states. In the current study, this fusion mechanism combined the emotion scores from the different modalities to produce a final attunement score between two dyads: therapist–withdrawer (male partner) and therapist–pursuer (female partner). Step 5 of Figure 1 demonstrates this process.

Quantitative analysis

Descriptive analysis of emotion states
We examined the distribution of seven emotions by running frequencies to report the count data for the therapist, withdrawer (male partner), and pursuer (female partner) separately and calculated density scores. In addition, we examined the prevalence of peaks of each emotion by running frequency and magnitude analysis during the session. This analysis revealed insights into how often and how intensely each participant experienced and expressed each emotion by modality. We calculated peak emotion to address the potential limitation of emotion models, which may be sensitive to subtle and momentary changes in voice and facial expressions. Examining peak emotion moments (those moments where the emotion signal reaches its highest intensity) provides a more stable and accurate representation of the emotional state.

Descriptive analysis of therapeutic attunement and comparison between dyads
We quantified synchronization events by counting the number of matching peaks of emotions between the therapist and each partner. We ran frequencies to report their count across the

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session. These values corresponded to the distribution of attunement in the session for each dyad (therapist–withdrawer and therapist–pursuer). In that analysis, we used aggregated data of emotions by integrating visual, audio, and textual data. In other words, we used the total count of emotional peaks for each individual in the session to detect attunement.

In addition, we categorized the attunement of therapist and client dyads by their timing: on-time attunement (OTA), therapist-initiated attunement (TIA), and delayed attunement (DA) and counted their frequencies across the session for each therapist–client dyad and emotion. For OTA, we counted the therapist's emotional peaks that coincided with the client's peaks within a two-time-step window. For TIA, we identified and counted instances where the therapist's peaks preceded the client's peaks within a 10-time-step window. For DA, we identified and counted instances where the therapist's peaks followed the client's peaks within a 20-time-step window. These time-step windows were chosen based on expected response times and validated through empirical testing and expert consultation as recommended by Binuya et al. (2022). Finally, we ran chi-square tests to examine differences between groups. Specifically, we compared therapist–withdrawer and therapist–pursuer dyads in their TA for each emotion. We also compared TA types across seven emotions and dyads.

Qualitative analysis

The computational and quantitative analysis allowed us to see the peak points of the session for TA. Next, we identified the time stamped segment of the session as an example of peak TA and analyzed the content of that segment. The first author (a second-year clinical psychology graduate student who has taken an EFT course and supervision as part of her master's program) watched the segments and coded them in terms of their alignment with EFT techniques. The third author (an ICEEFT-certified EFT therapist and a supervisor with 22 years of clinical experience) watched the session independently and oversaw the first author's coding process and technique interpretation. The significant moments in the session were thoroughly examined where EFT techniques, such as enactment and deepening, emerged. The authors then interpreted and discussed the content in terms of the alignment between EFT techniques and attunement.

RESULTS

Therapist's and clients' emotional states and expressions

Frequency of emotions for each individual in the session

Using text, auditory, and image data, we calculated the frequency of each emotion by density values that estimated the prevalence of each emotion in the speaker's overall emotional expression, including both verbal and nonverbal cues. For the pursuer (female partner), the most frequently expressed emotion was sadness, with a density of approximately 0.65, followed by joy (density = 0.25), and fear (density = 0.10). The expressions of anger and neutral emotion were minimal, with densities around 0.01 and 0.02, respectively. Disgust and surprise were nearly absent, each with a density close to 0.00. These findings indicated that the pursuer predominantly expressed sadness, with joy also being significantly present. For the withdrawer (male partner), fear and sadness were the most frequently expressed emotions, with densities of approximately 0.40 and 0.39, respectively. These emotions were significantly more prevalent than other emotions such as neutral (density = 0.07), anger (density = 0.05), and happiness (density = 0.03) for the withdrawer. Similar to the pursuer, estimated densities of disgust and

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surprise were close to 0.00. These results suggested that the withdrawer's emotional expression was dominated by fear and sadness, highlighting a significant focus on these negative emotional states. For the therapist, the most frequently expressed emotion was sadness, with a density of approximately 0.68. Other emotions displayed considerably lower densities with fear (density = 0.12), followed by anger and joy (each 0.05). Neutral emotion, disgust, and surprise were nearly absent, ranging from 0.00 to 0.01. These findings indicated that the therapist predominantly expressed sadness during the session, with other emotions being significantly less frequent.

The magnitude of peak emotions

The computational analysis of the 60-minute session video yielded 726 time stamps each for audio, text, and image data. The distribution of the peak emotions for each individual and by modality is illustrated in Table 1. The most common peak emotions that were expressed throughout the session were anger (n = 2,419) and sadness (n = 1,613), whereas surprise was the least frequently expressed emotion among all seven emotions (n = 100) across all individuals. However, the peak emotion frequencies differed across individuals in the session. The therapists' most expressed peak emotions were sadness (n = 748), neutrality (n = 455), and joy (n = 304). For both clients, anger was the most expressed peak emotion with scores of 1,098 and 1,166 for the withdrawer and the pursuer, respectively.

Regarding modality, there were variations across text, audio, and image data. For instance, sadness was a prevalent emotion among all participants, especially in the image modality for the therapist and pursuer, whereas anger was more common in auditory and textual data for both partners. In addition, joy was the therapist's most frequently expressed emotion for audio results (n = 231), whereas it was the least frequently expressed emotion for text results (n = 26).

Therapeutic attunement in EFT sessions

Prevalence of attunement: Peak matching counts by dyads

We operationally defined therapeutic attunement as the session moments where the peaks of the emotion lines overlapped or were closely aligned between the therapist and each client. Computational analysis revealed 808 unique TA moments across the session. Specifically, the therapist's peak emotion scores aligned with the withdrawer's scores 482 times and with the pursuer's scores 326 times during the session. Table 2 summarizes the number of attunement instances across the session for each emotion and dyad (therapist–pursuer and therapist–withdrawer).

The chi-square test indicated that the peak alignment frequency differed significantly between the two clients, $\chi^2(1, N = 808) = 14.81$, $p < .001$. That is, the therapist's emotional peaks were significantly more frequently aligned with the withdrawer's emotional peaks than those with the pursuer's, suggesting higher TA. For a closer look at the dyad differences in TA, we examined each emotion by Chi square tests. Specifically, the therapist–withdrawer dyad displayed significantly more TA moments for fear (n = 177, 21.91%), neutral (n = 116, 14.36%), and joy (n = 114, 11.39%) than the other dyad. The therapist–pursuer dyad predominantly displayed significantly more TA over sadness (n = 60) than the other dyad (n = 30; Table 2).

Attunement types

Of 808 TA interactions, 162 (20.05%) were on time, 290 (35.89%) were therapist initiated, and 356 (44.06%) were delayed (Table 2). The chi-square test indicated that the therapeutic

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TABLE 1 The magnitude of peak emotions detected for each individual in the session by modality.

	Therapist				Withdrawer				Pursuer				Total
	Audio	Image	Text	Total	Audio	Image	Text	Total	Audio	Image	Text	Total	
Anger	47	54	54	155	514	54	530	1,098	579	1	586	1,166	2,419
Joy	231	47	26	304	121	26	21	168	18	194	10	222	694
Disgust	219	0	35	254	18	0	11	29	37	0	4	41	324
Surprise	0	0	80	80	0	0	7	7	0	0	13	13	100
Fear	23	95	64	182	8	306	18	332	4	52	2	58	572
Sadness	133	516	99	748	19	294	16	329	50	472	14	536	1,613
Neutral	73	14	368	455	46	46	123	215	38	7	97	142	812
Total	726	726	726	2,178	726	726	726	2,178	726	726	726	2,178	

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TABLE 2 The number of therapeutic-attunement moments by each emotion, dyad, and attunement type.

	Dyad		Attunement type			Total emotions	
Emotion	Therapist–withdrawer (*n*)	Therapist–pursuer (*n*)	On time (*n*)	Therapist initiated (*n*)	Delayed (*n*)	*n*	%
Anger	8	2	2	5	3	10	1.24
Joy	114	92	44	69	93	206	25.50
Disgust	30	28	9	26	23	58	7.18
Surprise	7	21	6	15	7	28	3.47
Fear	177	33	43	59	108	210	26.0
Sadness	30	60	17	30	43	90	11.14
Neutral	116	90	41	86	79	206	25.50
Total	482	326	162	290	356	808	100

attunement types did not differ significantly between the two clients, $\chi^2(2, N = 808) = 0.148$, $p = .928$. This finding shows that the therapist's timing of TA was similar for both clients. Additionally, the attunement types did not differ significantly across seven emotions, $\chi^2(12, N = 808) = 18.644$, $p = .098$. That is, therapist attunement timing did not differ by emotions.

Alignment of TA and EFT techniques

In an attempt to examine the TA moments more closely, we subsampled 202 attunements focusing on emotions with the highest frequency (fear and joy) and an important emotion for the session content (sadness). These attunements were rewatched at five points where emotion peaks and attunement seemed high in the original session. In total, we analyzed approximately 5 minutes of each attunement type, thoroughly examining the content for alignment with EFT techniques and attunement.

Emotion recognition and EFT

When we examined the session moments associated with peak sadness emotion, it was especially salient for the pursuer, who showed intense vulnerability to be accepted and validated by the partner. Consistent with EFT theory and conceptualization (Johnson, 2004), we observed the pursuer frequently expressing sadness to elicit responses and create a sense of connection. On the other hand, for the withdrawer, fear and sadness were the most frequently expressed emotions (see Table 1). A close examination of the session video demonstrated several instances of fear and sadness. For instance, toward the end of the session, the therapist explored the withdrawer's underlying emotion as fear and enacted a process to express his fear (as helplessness) to his partner. Although the withdrawer was not initially aware of his underlying emotions, the therapist was able to uncover them, as they were evident in his facial expressions from the beginning. Following the enactment technique, we observed that the withdrawer had increased emotional processing, especially for fear, followed by sadness and disgust.

Furthermore, the focus of the TA shifted throughout the sessions. There were instances of evident TA with one partner but not the other, influenced by the therapist's goal to uncover underlying emotions shaping interactions (Greenman & Johnson, 2013). In this session, some peak emotion and TA moments that were captured by the computational analysis were

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moments that the therapist was using enactment techniques to process emotions. During these events, therapists may appear more attuned to one partner while temporarily overlooking the other. This selective attunement is not surprising because, in an attachment context, expressions of intense emotions such as fear may elicit sympathetic concern and a desire to provide comfort (Johnson, 2004). As such, the therapist may be selectively attuned to provide that sense of security to the client at that very moment.

Attunement types and EFT

On-time attunement

Because the selected video was a Stage 1 EFT training session with Steps 3, 4, and 5, the therapist was working on accessing and reprocessing underlying emotions. Therefore, OTA instances aligned with the moments that the therapist was attuning to fear of the withdrawer and sadness of the pursuer. Joy-specific results showed the highest OTA instances, particularly when the therapist joined the clients' laughter or when clients expressed relief after enactments. Common techniques during these moments included heightening emotions, validation, reflection, and deepening. An exemplary moment occurred at the beginning of the session when the therapist rearticulated the clients' words, demonstrating OTA. When the pursuer said, "Yeah. So, but I still, it lacks the connection," the therapist immediately responded, "It lacks that connection. In a sense, what will help you with your sad feelings is for Craig [the withdrawer's name] to come close" (Johnson, n.d., 17:44). The therapist's OTA over sadness further encouraged the pursuer to process and express her sadness more intensely.

Considering the low anger attunement (see Table 2), when the client's anger was intense, the therapist initially aligned with this state and then regulated the client's emotional level. In marital conflicts, angry defensiveness often replaces hurt, fear, or other primary emotions. The therapist focused on primary emotions instead of the anger that was masking them, therefore, anger TA decreased in those moments. This approach, known as unpacking, involves labeling anger into elements like helplessness or fear (Johnson, n.d., 2004).

Therapist-initiated attunement

Fear was one of the most frequently detected emotions in TIA instances in our computational analysis. To examine these moments, we rewatched key segments of the session. Initially, the withdrawer expressed his struggle with uncertainty, which the therapist identified as fear and helplessness. As she explored these emotions with him, his fear levels increased following the therapist. The therapist used deepening questions like, "Where do you feel that in your body?" and statements such as, "Everything's going wrong. You don't know what's going to happen?" (Johnson, n.d., 47:24). This approach helped the withdrawer dig deeper into his emotions. The therapist then summarized these feelings and asked him to share them with his wife, increasing both their fear scores due to the enactment. Sue Johnson explained at the end of the session that she used elements like body responses, triggers, and thoughts while feeling an emotion (Johnson, n.d.). We observed that these evocative questions, heightening techniques, and enactment facilitated TIA.

TIA was also evident when the therapist reflected and validated emotions, leading to increased emotional expression from the client. For example, the therapist engaged with the pursuer (a depressed female client), saying, "You feel physically alone, and there's a sadness that comes … and then you feel really lost" (Johnson, n.d., 22:26). This intervention moment was a peak sadness emotion incident for both the therapist and the pursuer, indicating TIA as the therapist deepened and reflected on the pursuer's emotions after she cried, recognizing her struggle to express them.

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Delayed attunement

We observed DA when the therapist took her time to deeply understand the clients' emotions. This resulted in the therapist's emotional score aligning closely with the clients' only after exploring their feelings. Delays often occurred due to conflicting or ambiguous emotions. For example, we found DA moments for joy when the pursuer expressed hope that her partner (withdrawer) would understand her. Following this moment, discussions about her worries and needs led to a temporary decrease in joy, but her hope was later expressed again, and the therapist attuned to her emotions after managing conflicting cues. This DA moment was closely aligned with the exploratory questioning technique of EFT. Of note, during hopeful expressions, the client's image data showed increased fear and sadness, and audio data indicated high sadness. Happiness scores in the image results did not align with text results, revealing contradictions. In such moments, the therapist first addressed other worries, then attuned to both joy and sadness or fear. Lastly, when the withdrawer mentioned helplessness with a laugh, the therapist initially seemed unaligned. However, she soon identified the emotion as helplessness, using a joyful tone to attune to the withdrawer's underlying feelings despite the conflicting emotional expression. As such, DA moments in the session exemplified the complex nature of couples therapy where the therapist was working with ambiguity.

DISCUSSION

The current study aimed to examine emotional expressions and TA in an EFT session. Using multimethod and multimodal data analysis, we found distinct emotional expressions and attunement types among the therapist–pursuer and therapist–withdrawer dyads. Our findings illustrated that the TA moments aligned closely with the EFT techniques, suggesting real-time evidence of how EFT can uncover, process, and heighten emotions in couples therapy.

One of the key findings of our study was related to the density of basic emotions and peak emotions across the session. According to our magnitude of peak emotions results, the therapist's most common peak emotions were sadness, neutrality, and joy. This finding aligned with the clients' frequent expressions of sadness and reflects the emotional tone of the session. Similarly, the therapist's most common neutral and joyful expression may support the idea that being attuned to others requires maintaining a certain level of calmness within oneself (Johnson, 2008, 2020). On the other hand, for both partners, anger was the most frequently expressed peak emotion, however, this finding was not replicated in density scores. Instead, density scores showed that the pursuer predominantly expressed sadness whereas the withdrawer expressed fear and sadness. These contradictory findings highlight the complexity of emotional expressions in couples therapy, where intense emotions like anger often mask underlying feelings such as fear and sadness (Johnson, 2020).

Affective attunement begins with recognizing the significance of the other person's emotions as an important aspect of their communication, being open to experiencing emotions triggered by the other person, and responding with reciprocal emotions (dos Santos, 2022). Consistent with that definition, our findings underscored the therapist's ability to initiate attunement by effectively recognizing the clients' most intense and peak emotions. Our analysis revealed that the pursuer primarily expressed sadness whereas the withdrawer intensely showed both fear and sadness. Similarly, the therapist was more likely to be attuned to the pursuer's sadness and the withdrawer's fear, both of which correspond to the key attachment emotion for each partner. In EFT, expanding the key attachment emotions requires maintaining focus on these emotions and processing them fully, instead of quickly regulating them (Elliott & Macdonald, 2021; Johnson, 2004, 2019; Seedall & Sandberg, 2020). Therefore, the intense expression of these emotions aligned with EFT expectations. Additionally, the therapist's most frequently expressed emotions mirrored those most commonly expressed by the clients. Our TA findings

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support the idea that EFT therapists should be able to attune to couples and empathically connect with their emotional experiences (Johnson 2019, 2020; Seedall & Sandberg, 2020; Talia et al., 2020). Specifically, our results showed a strong alignment between the emotional states of the couple and the therapist, indicating high attunement.

Furthermore, TA was more frequent between the therapist and the withdrawer than with the pursuer. Analysis of the peak TA moments with the withdrawer in the session video revealed that the therapist was using repetition or refocusing techniques (Beasley & Ager, 2019; Johnson, 2004, 2019) more with that client, especially during enactment. This could be due to the attachment style of the withdrawer who is more likely to avoid intense emotions and move away when distressed. Therefore, the therapist may be using TA to bring him back to the emotion.

Another important finding of our study was that the therapist's timing in showing TA was consistent across different clients and emotions. This finding indicates the high expertise and skills of the therapist in maintaining an attuned connection. Skilled therapists can maintain consistent timing while effectively adjusting the emotional focus of the attunement. Although the timing of attunement did not differ, the content of the attunement—specifically, the emotions the therapist focuses on—varied according to the client's attachment needs. This adaptability is crucial in addressing the unique emotional states and requirements of each client, ensuring that the therapeutic process is tailored to their individual needs.

Alignment of TA and EFT techniques

Our emotion recognition scores and attunement instances align with EFT techniques. Sadness, grief, and helplessness are typical reactions to an unresponsive attachment figure (Johnson, 2004, 2019; Seedall & Sandberg, 2020), which our emotion recognition results reflect. These results are consistent with the withdrawer–pursuer dynamics previously stated. Consequently, EFT techniques supported our understanding and interpretation of the TA scores when examining the session's characteristics. The examined session was a Stage 1 session, therefore, the therapist focused on building an alliance, identifying the negative cycle and the unacknowledged emotions underlying it, and reframing the couple's problems in terms of the cycle, underlying emotions, and attachment needs (Johnson, 2019). Our attunement scores reflected these Stage 1 techniques. The therapist was sensitive to being attuned to building an alliance, and while understanding and reframing the cycle, consistently referred to the underlying emotions and attachment needs.

Moreover, using general EFT techniques such as heightening emotion, rearticulation, or interpreting the emotions expressed by the clients (Johnson & Greenman, 2006; Stiegler et al., 2018) resulted in high TA. More specifically, when a client expresses sadness, the therapist's empathetic response and compassionate gestures enhance the interpersonal bond (Johnson, 2004). Likewise, when a client experiences fear, the therapist's reaction conveys security and protection through both effect and action by attuning (dos Santos, 2022). Consequently, different attunement types correlated with specific EFT techniques: immediate responses, reflections, and validations for OTA; exploring and deepening clients' emotions, often through evocative questions and summarization of feelings for TIA; and exploratory questioning and managing multiple emotional cues for DA.

Attunement is conveyed not only through verbal communication but also through the therapist's facial and body language, signaling to the client that their emotions and needs are acknowledged, significant, and impactful (dos Santos, 2022). Therefore, utilizing a multimodal analysis incorporating voice, word selections, and facial expressions proved to be instrumental in comprehensively discerning the dynamics of attunement. Understanding these patterns can help therapists tailor their approaches to address the specific emotional needs of their clients, enhancing the effectiveness of therapeutic interventions.

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Limitations and future research

Our research is not without limitations. First of all, we acknowledge that this is a case study of a single EFT couples session, which provides only a snapshot of Stage 1 of the EFT model. Given that TA grows over time throughout the therapy process, a more comprehensive examination of emotions would require several videos of the same couple from each stage to fully grasp the change in TA. Future research could address that limitation. Moreover, our study utilized text, video, and image data to capture both verbal and nonverbal interactions. Although this strategy allowed for more rigor and reliability of our findings, it also brought additional challenges. For instance, there were so many data points of emotional expressions that it resulted in noise in the data, which increased false positives for TA moments. However, we addressed this issue by focusing on peak emotion moments, rather than each emotion time stamp, for analysis of TA. Yet, our models were limited in precision and may have failed to examine each TA moment. As recognizing each emotion in a session for a human being seems impossible, this study aims to provide an improvement in this area. Future ML techniques can be utilized to examine almost every attunement moment in therapy sessions.

Likewise, the therapist demonstrated in these videos is Sue Johnson, a widely recognized master therapist and the pioneer of EFT. Given her extensive expertise in this field, the attunement outcomes appear to be exceptional. It is worth noting that therapists possess varying qualifications and may attune clients differently based on their attachment styles (Talia et al., 2020). Therefore, the diverse qualifications and attachment styles among therapists can potentially produce different results. There is a need for further research to examine TA processes in interaction with therapists' skills, attachment style, and expertise. Finally, some low scores of TA and emotions remain unexplored. For instance, regarding the therapist's attunement to surprise, our recognition scores demonstrated several low attunement moments. The reason behind the instances where the withdrawer's surprise level showed a high probability while the therapist's did not can be related to the limitations of our model's image recognition.

Implications

Our study holds significant implications for both clinical practice and research methodology. Our findings underscore the interconnection between attunement and EFT techniques, including heightening emotion, tracking emotional cues, withdrawer reengagement, and pursuer softening, in facilitating the change process during Stage 1 of the model. It appears that tracking emotional cues and heightening emotions are associated with enhanced attunement, yet there are fluctuations and lags between therapists' and clients' emotional expressions. Furthermore, our preliminary results indicate the feasibility of employing MoEs to track and comprehend attunement dynamics in therapy sessions. ML with MoEs presents a promising novel methodology in research focusing on the couples therapy process. This allows therapists to systematically observe and analyze attunement's impact on therapeutic processes, gaining insights into factors contributing to any temporal delays. These findings also aid therapists in exploring potential ruptures within therapeutic relationships, as attunement significantly influences the quality of the therapeutic alliance (Rocco et al., 2017). Such insights help therapists, supervisors, and trainers identify and understand obstacles within their therapeutic processes.

Conclusion

In summary, the system architecture captures session videos and processes them through a series of ML models to recognize speech, identify speakers, and analyze emotions from textual,

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auditory, and visual data. The integration of these multimodal emotion scores through an MoE model results in a comprehensive attunement score, facilitating insights into emotional attunement during client sessions. By examining emotional interaction during therapy, particularly the timing of therapist attunement, psychotherapy effectiveness can be enhanced. However, therapists cannot currently observe their therapeutic attunement moment-by-moment, especially during couple sessions. This study is the first to demonstrate attunement throughout a couples therapy session and its integration with EFT techniques.

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