

Within- and between therapist variability in movement and physiological synchrony and its effects on symptom change

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Abstract

The predictive power of movement and electrodermal activity (EDA) synchrony has been demonstrated in various studies. Although most studies have examined each synchrony modality separately, a growing interest in the simultaneous investigation of multiple modalities has emerged. Previous research has demonstrated the importance of disentangling within and between-dyad effects, however within and between-therapist effects have yet to be investigated. The aim of the present study was to test whether movement and EDA synchrony (measured both within and between therapists) predict across-session symptom change in two types of interventions (emotion-focused vs. cognitive). The results are based on 990 session segments of 90 clients with test anxiety who were treated with a six-session treatment program by 22 therapists, treating 3–15 clients each. Movement synchrony (on the basis of motion energy analysis (MEA) values) and EDA synchrony were quantified using cross-correlations. Symptom severity was assessed before each session using the state test anxiety measure. Movement and EDA synchrony correlated negatively (-0.19 , $p < .001$). Moreover, higher movement synchrony as well as an interaction between movement and EDA synchrony was significantly associated with symptom improvement within, but not between therapists. In addition, an interaction between EDA synchrony and cognitive (versus emotion-focused) interventions was significantly associated with symptom improvement. These results provide initial evidence that therapists' average levels of synchrony may matter less than how synchronous they are with a specific client.

KEYWORDS

anxiety, electrodermal, interpersonal synchrony, movement synchrony, physiological synchrony, therapist effects

1 | INTRODUCTION

The spontaneous and temporally coordinated synchronization of actions is a fundamental human skill (Wiltshire

et al., 2020). In their recently published theory of flexible multimodal synchrony, Gordon et al. (2023) postulate that social interactions are driven by two tendencies, synchronization (synchronize with others) and segregation (move

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out of synchrony and act independently), in behavioral (e.g., movement), physiological (e.g., EDA), and neuronal modalities. The tendency to synchronize and segregate is determined flexibly and adaptively by the context, but is also influenced by a person's individual characteristics. A growing number of studies have linked different forms of interpersonal coordination to important concepts and outcomes in a variety of areas, including psychotherapy (e.g., Ramseyer & Tschacher, 2011).

Psychotherapy is perhaps one of the most complex bio-psycho-social systems (Wiltshire et al., 2020), in which movement (e.g., Paulick et al., 2018; Ramseyer & Tschacher, 2011, 2014) and EDA synchrony (e.g., Bar-Kalifa et al., 2019; Marci et al., 2007) have already been studied. However, to date, the majority of studies have examined the different modalities separately, often reaching inconsistent results. As Mayo and Gordon (2020) as well as other researchers suggest, further studies should examine multiple synchrony modalities simultaneously. Otherwise, it is difficult to put the results into context and generate a clear understanding of the complex associations between the different modalities and a holistic understanding of the therapeutic processes at work (Atzil-Slonim et al., 2023).

Movement synchrony refers to the temporal movement coordination between interacting partners. One of the most commonly applied approaches to quantify movement synchrony in psychotherapy research is Motion Energy Analysis (MEA; Altmann et al., 2020; Ramseyer & Tschacher, 2011; Schoenherr et al., 2019). MEA is an automated method of measuring simultaneous and slightly time-lagged movements of client-therapist dyads (quantifying a synchrony index based on pixel changes).

EDA synchrony refers to the temporal coordination in electrodermal activity between interacting partners. EDA is solely under the control of the sympathetic branch of the autonomic nervous system and is particularly sensitive to arousal stemming from emotional and cognitive processes, regardless of conscious awareness (Dawson et al., 2007; Sequeira et al., 2009).

A multimodal approach to investigate the association between movement synchrony and EDA synchrony requires the simultaneous assessment of both synchronies. It can be assumed that each modality contains unique information and that integrating this information can lead to a better understanding of the processes at work (Clark et al., 2020). Examining movement synchrony (containing information about clients' and therapists' simultaneous movements) in association with EDA synchrony (containing information about clients' and therapists' sympathetic arousal) can reveal a more nuanced picture of the associations between the coordination of clients' and therapists' body movements and sympathetic arousal. The interpersonal pull to synchronize or segregate is particularly high

in psychotherapy. Depending on the context and client characteristics, the client triggers a certain reaction in the therapist, which can take place in various modalities. The therapist's reaction can stabilize the client's behavior. A good therapist should recognize this pull and react accordingly, even on a non-verbal level, to support the client to solve their problems (Lutz et al., 2020).

These different non-verbal modalities do not always have to react in the same way. Important clues about the association between movement and physiological (heart rate) synchrony come from a single case study (Tal et al., 2023). The authors examined physiological synchrony as a moderator of the association between movement synchrony and therapeutic alliance and showed that in sessions when physiological synchrony was high, the association between movement synchrony and therapeutic alliance was not significant. The results of this study provide evidence that different synchrony modalities have separate functions. They also highlight the importance of a multimodal approach and point to potential clinical implications, such as the importance of increasing therapists' awareness of nonverbal processes.

The interactive effect of movement and EDA synchronies may reflect several patterns of association (Mayo & Gordon, 2020). From a clinical perspective, movements could reflect attempts to regulate EDA arousal. A long history of literature exists supporting the idea that bodily movements can affect emotional experience (e.g., Rossberg-Gempton & Poole, 1993). For example, relaxing muscles may reduce feelings of guilt and anxiety (Laird, 1984), which, in turn, may be reflected in a decline in EDA. In such cases, we would expect high EDA synchrony (i.e., client and therapist simultaneously experiencing EDA arousal) to be related to high movement synchrony (i.e., client and therapist move simultaneously to regulate such arousal). From a methodological viewpoint, one could argue that movement and EDA synchrony will be not significantly associated. Prior research has shown that the amount of variance explained by individual modalities is small. Thus, each modality may hold unique information (Clark et al., 2020). These two alternatives are theoretical and have yet to be investigated. Therefore, one aim of the current article is to examine movement and EDA synchrony simultaneously measured over the course of multiple sessions. Specifically, we tested the idea that movement synchrony (measured using MEA) and EDA synchrony are correlated. Furthermore, we examined whether both movement and EDA synchrony are associated with symptom change.

Despite the growing number of studies examining the potential costs or benefits of synchrony (whether movement or EDA), results remain inconsistent. Several studies have shown a positive association between synchrony and outcome (Altmann et al., 2020 for movement

synchrony; Prinz et al., 2022 for EDA synchrony). In contrast, Lutz et al. (2020) found negative associations between movement synchrony and outcome. In their study, early change patterns of interpersonal problems were examined in 212 patients. The results showed that lower levels of movement synchrony were significantly associated with fast improvement. Studies examining the association between synchrony and process variables have also yielded mixed results (e.g., Andreas et al., 2023; Ramseyer, 2020a; Ramseyer & Tschacher, 2011). Uhl et al. (2023) investigated the association between in-session EDA synchrony and clients' emotional processing, finding moderate levels of EDA synchrony to be associated with greater emotional processing.

Multiple aspects may contribute to these mixed findings (for both outcome and process variables). First, methodological inconsistencies in the quantification of synchrony such as differences in maximal lags, and segment length may be a factor. For example, some studies analyzed the initial 15 min (or less) of a therapy session, while others examined index synchrony for the entire session (e.g., Paulick et al., 2018; Schoenherr et al., 2019) or based their results on solely on a single session (e.g., Paulick et al., 2018). One possible reason for these inconsistent results may be the studies' designs. Specifically, most studies used one synchrony index for the entire session. In recent years, however, evidence has emerged to support the idea that synchrony is a dynamic construct that can change over time and is linked to the content of a session (e.g., Zilcha-Mano, 2019). One approach to address this problem is to disentangle within and between effects of synchrony. A study by Prinz, Boyle, et al. (2021) demonstrated that movement synchrony differed according to the therapeutic strategies applied. In their study, 423 video-recorded sessions of 175 patient-therapist dyads were analyzed using MEA to quantify movement synchrony and examine its association with Grawe's general mechanisms of change (Grawe, 1997). The results showed that movement synchrony was associated with higher mastery as well as less resource activation and was not associated with problem actuation or motivational clarification. Similarly, in their study of 26 patient-therapist dyads, Bar-Kalifa et al. (2023) found that EDA synchrony varied depending on the emotional experience. This research highlights that synchrony might be a dynamic process related to the situational context. Given these findings, we sought to investigate movement and EDA synchrony depending on the context. Specifically, we examined segments of synchrony during an emotion-focused imagery-based intervention versus a cognitive intervention. In psychotherapy, emotions are a central element. Emotional processing, such as expressing and recognizing emotions as well as regulating or even co-regulating them, is postulated to be a key mechanism

of psychotherapy (Cuthbert et al., 2003; Greenberg & Watson, 2006). Accordingly, several studies have shown emotional processing and outcome to be associated (e.g., Cuthbert et al., 2003; Hendricks, 2002; Uhl et al., 2023; Watson & Bedard, 2006). Emotions affect physiological states by increasing and decreasing arousal depending on the emotion (Kreibig, 2010). Given that therapy is an interpersonal process, both the client and therapist process emotions and may regulate or dysregulate each other. Emotions are not only associated with physiological arousal, body movements and non-verbal behaviors are also central elements of emotions (Eteläpelto et al., 2018). For example, a client who is feeling shame might hold his hands in front of his face or a client who is experiencing distress might rub her hands over her legs for regulation. With regard to movement synchrony, Tschacher et al. (2014) showed that movement synchrony was higher in situations characterized by high emotional load. Therefore, we expected to find that EDA and movement synchrony would be higher during emotion-focused segments, when clients get more in touch with their emotions share their experience with their therapists, and both become more physiologically activated, which is likely visible on a non-verbal level.

With regard to the aforementioned situational differences, so far these have mostly been investigated at the client level (differences across sessions and between clients). However, synchrony is a dyadic phenomenon, likely not only related to variances within and between clients, but also within and between therapists. Clinically speaking, this means that therapists may not synchronize across all their clients in a certain way, depending on the evocative potency of a technique. It is possible that therapists' average levels of synchrony differ between their clients, that is, they may synchronize more with one client than with the other. Alternatively, Atzil-Slonim et al. (2023) hypothesized that synchrony might be a core therapist non-verbal skill. Meaning, that therapists may differ in their general ability to synchronize. This alternative is supported by a study by Altmann et al. (2020). The authors showed that between-therapist movement synchrony has a larger effect on post-treatment outcomes than within-therapist movement synchrony. If this is the case, it would be important to more strongly target synchrony in clinical training to help therapists gain a greater awareness of non-verbal signals and synchronous as well as anti-synchronous moments in psychotherapy sessions (Atzil-Slonim et al., 2023). Therefore, the second aim of the current article is to examine the variability of movement and EDA synchrony at both within and between-therapist levels. Furthermore, the contribution of these two levels of synchrony in predicting symptom change will be investigated.

To summarize, client-therapist synchrony has been proposed as an underlying mechanism in therapeutic

processes. To date, studies on the effects of synchrony have relied mostly on data from one synchrony modality only, and thus could not clarify to what extent different synchrony modalities are measuring different constructs. Furthermore, most studies have analyzed within- and between-client associations and highlighted the dynamic nature of synchrony and its situational aspects. However, within- and between-therapist variability have been neglected so far. Such a focus could help to achieve a better understanding of synchrony as a therapist skill. Further, the evocative power of emotional activation in different techniques may affect the therapist's ability to synchronize and is, therefore, also an important factor to consider.

With these aims in mind, the following hypotheses guided our work:

Hypothesis 1. *Movement and EDA synchrony will be positively associated.*

Hypothesis 2. *Movement and EDA synchrony will show significant variability at both the within-therapist and between-therapist levels.*

Hypothesis 3. *Both movement and EDA synchrony during emotion-focused interventions, but not during cognitive interventions, will be associated with symptom change.*

2 | METHODS

2.1 | Treatment

Treatments took place in an open trial study at two university outpatient psychotherapy clinics in Germany and Israel between 2016 and 2020 (Prinz et al., 2016, 2019). The test anxiety treatment protocol included six sessions of 50 min, each comprising an emotion-focused intervention (imagery work) as well as a cognitive intervention. The emotion-focused interventions were as follows: safe place imagery (session 1), exploration of an aversive situation (session 2), imagery rescripting of a past situation (sessions 3 + 4), and imagery rescripting of a future situation (sessions 5 + 6). The cognitive interventions were as follows: psychoeducation about test anxiety (session 1), identification of automatic and alternative cognitions and behaviors (sessions 2 + 3), review and adaption of learning and test-taking skills (sessions 4 + 5), and consolidation and content review of the entire treatment (session 6). The protocol is freely available online (www.osf.io/hraqd). The data included in this study are based on two different study designs. Due to experiences gained in an

initial pilot study, the study design was changed in 2017. Before 2017, the protocol was carried out over the course of 3 weeks. From 2017 onwards, the sessions took place on a weekly basis. Thus, the present sample includes dyads that had two sessions per week ($n = 24$), and dyads that met on a weekly basis ($n = 66$).

2.2 | Inclusion and exclusion criteria

A total of 205 potential clients were recruited using a campus newsletter. The following criteria were applied: (1) a score of 53 or above on the Test Anxiety Inventory (Spielberger, 1980), (2) no imminent risk of suicidality, (3) currently no other treatment addressing test anxiety. Based on these criteria, 40 participants were excluded. Twenty-nine additional participants dropped out after the intake examination. A total of 136 clients started treatment. Only client-therapist dyads in which the therapist treated at least three clients were included in the analysis. Forty-six dyads were excluded because the therapist treated less than three clients in the data set. Thus, the present analysis is based on a sample of 90 client-therapist dyads.

Each session was divided into two segments, one consisting of the emotion-focused intervention, and the other of the cognitive intervention. Ninety session segments (emotion-focused or cognitive work) were not eligible for quantification of movement or EDA synchrony due to technical problems (e.g., sessions were not video recorded or EDA signals were poor). Sessions were not excluded on the basis of content. A total of 990 session segments (of 1080 segments in total: $90 [\text{client-therapist dyads}] \times 6 [\text{sessions}] \times 2 [\text{imagery or cognitive work}]$) were analyzed.

2.3 | Clients and therapists

The sample comprised 90 clients (16 males, 74 females) with a mean age of 23.59 years ($SD = 4.19$, range: 19–39). Clients were pursuing studies in various fields, most commonly law, education science, and IT.

The sample consisted of 22 therapists (9 males, 13 females) with a mean age of 25.41 years ($SD = 2.12$, range: 24–31). In the present study, therapists treated 4.09 clients on average (range: 3–15). Sixteen therapists were graduates of a master's program in psychology and had no prior therapy experience; the remaining six therapists were doctoral-level students of clinical psychology, each with at least 1 year of prior experience as a clinician. Therapists were trained in the treatment protocol and received group supervision conducted by an experienced clinician after each session.

Client-therapist dyads were of the same sex in 45% of cases, and therapists were an average of 2 years older than their clients ($SD = 3.92$).

2.4 | Measures

2.4.1 | Motion energy analysis and the quantification of movement synchrony

Body movement was measured using Motion Energy Analysis for MATLAB (MEA; by U. Altmann and D. Schoenherr, publicly available at <https://github.com/10101-00001/MEA>). MEA computes the grayscale pixel differences between consecutive video frames for each client and therapist.

Several pre-processing steps were carried out before the application of MEA. First, specific regions of interest (ROIs) were defined for both the client and therapist. The ROIs included the upper body area, starting at the seat of the chair and including the free space around the head. Second, background ROIs (10×10 pixels) were used to identify noise in the person time series. This accounted for variations like light changes in the therapy room, which were subsequently controlled for (Altmann, 2013).

Following these initial steps, MEA was applied. Color changes were counted, if the grey value changed by 12 units. To prevent over- or underestimation of movements, the series of pixel changes was adjusted by the corresponding size of the ROI. Subsequently, to create a smoother data set, a moving median with a bandwidth of five was applied.

Then cross-correlation functions (CCF) were calculated using R's (R Core Team, 2021) rMEA package (function MEAccf; Kleinbub & Ramseyer, 2019) to split the time series into 5-s windows. Next, cross-lagged correlations with a time lag of ± 5 s were applied and, finally, the reference window was rolled over the time series in steps of 1 s. The CCF was averaged across windows and the maximal correlation was used as the synchrony index level (for a similar approach, see Prinz, Boyle, et al., 2021). This procedure is in line with recommendations by Altmann et al. (2020) and followed the steps described in Paulick et al. (2018).

To test whether average movement synchrony was greater than chance, we created surrogate data by pairing 1000 randomly selected time series sequences drawn from clients' pixel differences with an equal number of randomly selected time series sequences drawn from therapists' pixel differences and calculated the CCF of each of these random pairs. A simple, two-sided t -test was used to compare the observed movement synchrony values with the surrogate synchrony values ($t = 2.40$, $p = .01$).

2.4.2 | Electrodermal activity and the quantification of EDA synchrony

EDA was measured with two electrodes attached to the thenar and hypothenar of the non-dominant hand. The signal was recorded with a constant voltage method module (Becker Meditec, Karlsruhe, Germany) with a range of 0–100 microS and a sensitivity of 25 mV/microS and was acquired at 500 Hz (National Instruments multifunction module USB-6002) and 16-bit resolution with DasyLab V. 10 (National Instruments Ireland Resources, Limited). It was then down-sampled to 25 Hz and saved as an ASCII file. The EDA was recorded at 1-second intervals and averaged over 2-min segments for analyses.

EDA synchrony in the therapeutic dyad was measured using CCFs of the raw EDA data (see also Bar-Kalifa et al., 2019; Prinz et al., 2022). Before calculating the CCFs, the auto.arima function (prediction package for R: Hyndman et al., 2018) was used to remove the autocorrelated component for each EDA time series. Subsequently, the cross-correlations were calculated with a maximum delay of ± 10 s for each 2-min segment of the residualized EDA time series of the dyad. The maximum correlation was used as the synchrony index.

Similar to movement synchrony, we tested whether average EDA synchrony was greater than chance by creating surrogate data. A simple, two-sided t -test was used to compare the observed EDA synchrony values with the surrogate synchrony values ($t = 519.58$, $p < .001$).

2.4.3 | State test anxiety, evaluation apprehension, and efficacy measure

The State Test Anxiety, Evaluation Apprehension, and Efficacy Measure (Lawrence & Williams, 2013) is a 6-item self-report measure and was designed to assess students' test anxiety, evaluation apprehension, and efficacy and was completed by the client before each session. For the purpose of this study, we investigated the state test anxiety (STATE-TA) measure, which consists of two items: I feel anxious about taking this test; I feel distressed and uneasy about taking this test. The items are answered on a 7-point Likert scale ranging from 0 (*strongly disagree*) to 6 (*strongly agree*). The two items were aggregated to create a total score. Internal consistency was high in our sample ($\alpha = .87$).

2.5 | Analytic approach

The data features a hierarchical (three-level) structure: (a) sessions within clients, (b) clients within-therapists, and

(c) therapists. To address this structure, we utilized a multilevel approach.

2.5.1 | Within- and between-therapist variability

To examine within- and between-therapist variability in both movement and EDA synchrony, we estimated the following three-level hierarchical linear unconditional model:

$$\text{Movement synchrony}_{\text{sct}} = y_{000} + e_{00t} + u_{0ct} + r_{\text{sct}} \quad (1)$$

In the equation, the index *s* indicated the session, *c* the client, and *t* the therapist, with e_{00t} representing between-therapist variability, u_{0ct} representing within-therapist variability, and r_{sct} representing within-client variability. This analysis was conducted twice: once with movement synchrony and once with EDA synchrony as the dependent variable. The models yielded estimates for variance components of random effects, which were subsequently utilized to compute intraclass correlations (ICCs). These ICCs served as indicators of the proportion of variance explained at each level.

2.5.2 | Clients' mean symptom severity change rate

The average symptom severity change rate for each individual client, referred to as the client-specific slope, was calculated as follows. Each client's STATE-TA, which was assessed repeatedly at the beginning of each session, was modeled as a function of log10 of the session number. Following previous work (e.g., Lutz et al., 2007; Uhl et al., 2022) symptom change was modeled as a negatively accelerated function of the number of sessions, assuming that the most rapid response occurs early in therapy (e.g., dose-effect curves, Hansen et al., 2002). Within this model, the intercept parameter was determined by the client's pre-treatment symptoms. This anchoring procedure, as outlined by Elkin et al. (2006) and Lutz et al. (2007), allocates the entire change variance to the slope term. Consequently, this simplifies the model and enhances the reliability of the slope. Additionally, the model included residual components at Level 1 (r_{sct} —representing within-client variability), Level 2 (u_{0ct} —representing within-therapist variability), and Level 3 (e_{00t} —representing between-therapist variability). Subsequently, the average slopes per therapist were calculated by aggregating the client-specific slopes for each therapist.

2.5.3 | Predicting the change rate

To test the associations between interventions, movement as well as EDA synchrony, and symptom change, hierarchical linear models were used. In the first of these models (M0), aggregated client-specific slopes were modeled as a function of the pre-treatment STATE-TA score as well as a Level 2 random effect (u_{0t} —representing between-therapist variability), and a Level 1 random effect (r_{ct} —representing within-therapist variability). Subsequently, in each further model, an additional predictor was added: movement synchrony (varying within-therapists; M1), average movement synchrony (varying between therapists; M2), EDA synchrony (varying within-therapists; M3), and average EDA synchrony (varying between therapists; M4). Within-therapist synchrony was calculated by standardizing the mean synchrony with a specific client to the mean value of the respective therapist across all his/her clients. Between-therapist synchrony was calculated by standardizing the mean synchrony value of a specific therapist across all his/her clients to the mean value across all therapists. In addition, intervention (emotion-focused or cognitive) was included as a main effect, as well as an interaction with both Level 1 predictors. The final model also included the interaction between movement and EDA synchrony (M5).

$$\begin{aligned} \text{Slope_State}_{\text{ct}} = & \gamma_{00} + \gamma_{01} * \text{Pre-treatment symptoms}_{\text{ct}} \\ & + \gamma_{02} * \text{Intervention}_{\text{ct}} \\ & + \gamma_{03} * \text{Movement synchrony}_{\text{ct}} \\ & + \gamma_{04} * \text{EDA synchrony}_{\text{ct}} \\ & + \gamma_{05} * \text{Avg. Movement synchrony}_{0t} \\ & + \gamma_{06} * \text{Avg. EDA Synchrony}_{0t} \\ & + \gamma_{07} * \text{Movement synchrony}_{\text{ct}} * \text{Intervention}_{\text{ct}} \\ & + \gamma_{08} * \text{Movement synchrony}_{\text{ct}} * \text{Intervention}_{\text{ct}} \\ & + \gamma_{09} * \text{Movement synchrony}_{\text{ct}} * \text{EDA}_{\text{ct}} \\ & + u_{0t} + r_{\text{ct}} \end{aligned} \quad (2)$$

3 | RESULTS

3.1 | Correlation between movement and EDA synchrony

There was a small negative overall correlation between movement synchrony and EDA synchrony across both interventions ($r = -.19$; CI $[-0.28, -0.10]$; $p < .001$). Figure 1 shows the association between movement synchrony and

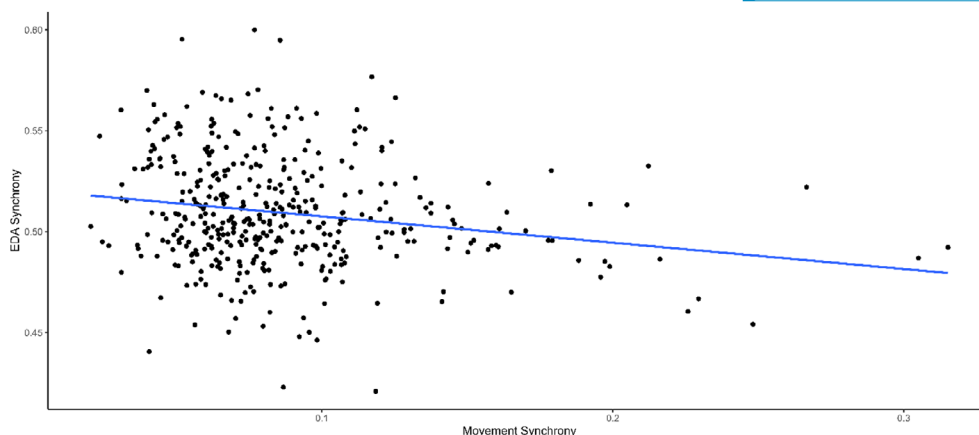


FIGURE 1 Correlation between movement and EDA synchrony.

EDA synchrony. The correlation between movement synchrony and EDA synchrony was significant on the within-level, $r = -.34$; CI $[-.40, -.29]$; $p < .001$. Similarly, the correlation between movement synchrony and EDA synchrony was highly significant on the between-level, $r = -.29$; CI $[-.35, -.23]$; $p < .001$.

3.2 | Variability in movement and EDA synchrony

Table 1 shows the random effects of both the movement synchrony and EDA synchrony models. The ICC indicated that there was variance in movement synchrony on both the within-therapist (ICC = .16) and between-therapist (ICC = .13) levels. Similarly, for EDA synchrony, there was variance on both the within-therapist (ICC = .16) and between-therapist (ICC = .23) levels.

3.3 | Clients' mean symptom severity change rate

Table 2 shows the three-level model predicting the state test anxiety measure over the course of treatment as a function of log10 of the session number. The clients' individual slopes ranged from -1.530 to 0.350 ($M = -0.430$, $SD = 0.416$).

TABLE 1 Random effects of three-level null models portioning variance in movement synchrony and EDA synchrony.

Random effects	Movement synchrony			EDA synchrony		
	Variance	SE	ICC	Variance	SE	ICC
Between therapist	0.0004	0.018	.126	0.0001	0.013	.239
Within-therapist	0.0003	0.021	.162	0.0001	0.010	.160
Residual	0.002	0.043	.712	0.0004	0.020	.601

Abbreviations: ICC, intraclass correlation, SE, standard error.

3.4 | Predicting the change rate

The two-level model predicting the symptom severity change rate is displayed in Table 2. Therapist differences accounted for 20.2% of clients' change rate in the null model. The intercept indicated that the mean symptom severity change rate for a therapist's average client was -0.43 (CI = -0.54 to -0.32 , $p < .001$). By successively adding predictors to the model, movement synchrony ($b = -3.57$, CI = -7.10 – -0.04 , $p = 0.048$) and not EDA synchrony ($b = -3.84$, CI = -11.33 – 3.60 , $p = 0.310$) was associated with symptom change on Level 1. Furthermore, the interaction between EDA synchrony and intervention ($b = 6.41$, CI = 2.04 – 10.78 , $p = .004$) as well as the interaction between movement and EDA synchrony ($b = 61.83$, CI 10.35 – 113.30 , $p = .019$) were associated with symptom change on Level 1. Figure 2 illustrates that clients reported greater symptom change when the client-therapist dyad showed less EDA synchrony during the cognitive intervention. As presented in Figure 3, the interaction effect between movement and EDA synchrony means higher movement synchrony was associated with greater symptom change when their EDA synchrony was low (Table 3).

3.5 | Additional analyses

To test the stability of both movement and EDA synchrony across sessions, we ran an additional series of multilevel

models. For movement synchrony, significant differences across sessions were found (across both interventions: $b = -0.004$, $SE = 0.0001$, $p = .002$, for emotion-focused interventions: $b = -0.001$, $SE = 0.0002$, $p < .001$, and for cognitive interventions: $b = 0.0003$, $SE = 0.0001$, $p = .007$). Across both interventions, on average therapists showed more movement in the first session compared to later sessions (Figure 4a). This pattern was also found in the emotion-focused intervention (Figure 4b). In the cognitive intervention, therapists showed a continuous increase in movement synchrony across sessions (Figure 4c). For EDA synchrony, significant differences across sessions were only found for emotion-focused interventions (across both interventions: $b = 0.0001$, $SE = 0.000$, $p = .101$, for emotion-focused interventions: $b = 0.0002$, $SE = 0.000$, $p < .001$, and for cognitive interventions: $b = 0.000$, $SE = 0.000$, $p = .298$). Across both interventions, on average therapists showed an increase in EDA synchrony across sessions (Figure 4d).

This pattern was also found in the emotion-focused intervention (Figure 4e). In the cognitive intervention, on average therapists showed less EDA synchrony in session 1 compared to later sessions (Figure 4f).

To test whether outliers, especially in movement synchrony, drive the negative association between movement synchrony and EDA synchrony as well as the interaction between both variables, we ran additional sensitivity analyses. First, we calculated Sn (Rousseeuw & Croux, 1993) to identify outliers for both movement and EDA synchrony. Sn is a fence method that assumes that data within a calculated range are not outliers, while data outside this range are classified as outliers. For movement synchrony, we found 18 outliers, all above the upper cut-off. For EDA synchrony, there were 5 outliers, 2 below the lower and 3 above the upper cut-off. Second, we removed these data points and recalculated the correlation. The results remained similar, still showing a negative correlation

TABLE 2 Symptom severity (state test anxiety measure) as a negatively accelerated function of the number of sessions.

Fixed effects	Coefficient	SE	<i>t</i>	<i>p</i>
Log ₁₀ (session)	−0.430	0.079	−5.451	<.001
Random effects	Variance	SD		
Therapist	0.076	0.276		
Client	0.253	0.503		
Initial symptom severity (intercept)	24.107	4.910		
Residual	0.571	0.755		
Explained variance	<i>R</i>²			
Marginal <i>R</i> ² (variance explained by fixed effects)	.003			
Conditional <i>R</i> ² (variance explained by random and fixed effects)	.977			

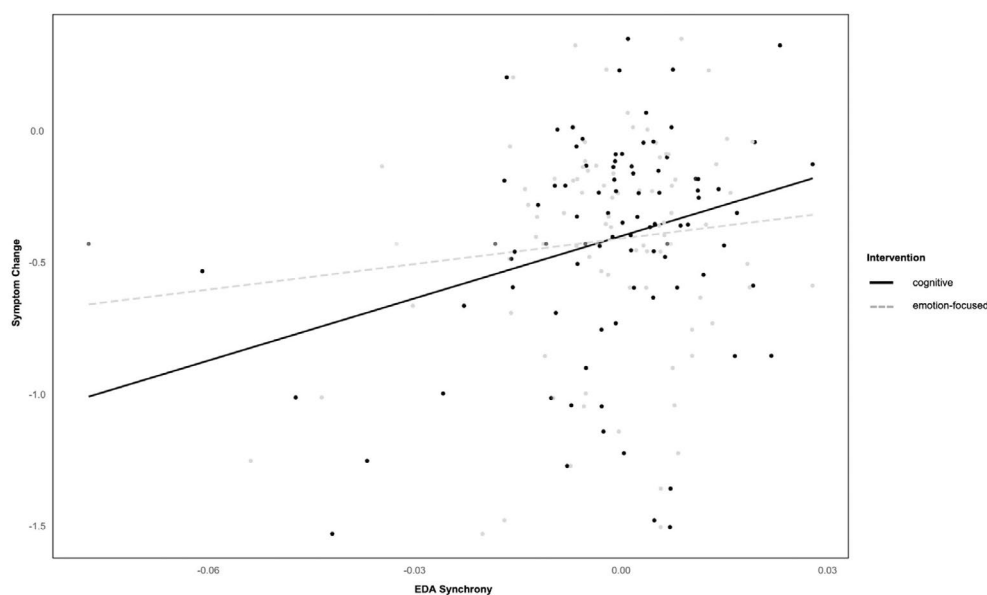


FIGURE 2 Interaction effect of EDA synchrony and intervention with symptom change.

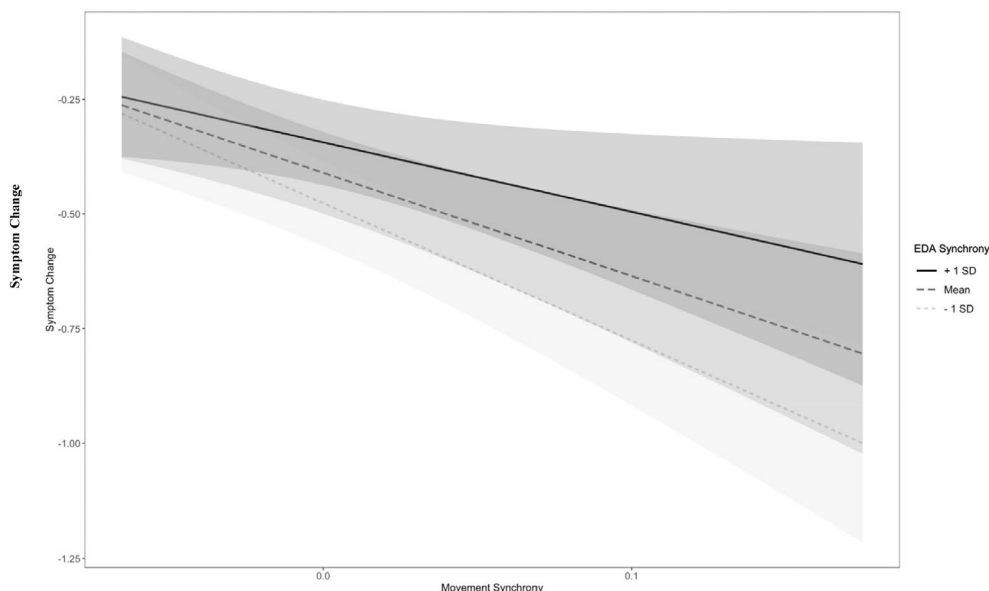


FIGURE 3 Interaction effect of movement and EDA synchrony with symptom change.

between motion synchrony and EDA synchrony ($r = -.14$; CI $[-.23, -.04]$; $p < .01$). Third, we ran the final model based on the new data set. Movement synchrony on Level 1 was a marginal significant predictor of symptom change ($b = -2.72$, CI $= -5.80 - -0.35$, $p = 0.082$). Furthermore, the interaction between EDA synchrony and intervention ($b = 5.62$, CI $= 1.85-9.39$, $p = .003$) as well as the interaction between movement and EDA synchrony ($b = 52.87$, CI $= 8.34-97.40$, $p = .020$) remained significantly predictive of symptom change (Table 4).

4 | DISCUSSION

The present study examined the associations between movement and EDA synchrony and their predictive validity for symptom change in the treatment of test anxiety. Synchrony was examined during segments involving two different intervention types (emotion-focused and cognitive interventions) and variability in synchrony was modeled both within and between therapists. To our knowledge, this is the first study to examine: (a) the association between movement and EDA synchrony, (b) the variability in these two synchrony modalities on within and between therapist level, and (c) their associations during emotion-focused vs. cognitive-oriented interventions with symptom change. Below we discuss the results related to each of the study's aims in greater detail.

The first aim of our study was to examine the association between movement and EDA synchrony. Contrary to our hypothesis, movement and EDA synchrony showed a small negative correlation. At first glance, this result

seems surprising. When therapists show high EDA synchrony with a client, they tend to have low movement synchrony with this specific client and vice versa. In their theory of flexible multimodal synchrony, Gordon et al. (2023) described a positive association between movement and physiological synchrony when there is a stronger pull to synchronization compared to segregation within the context. Psychotherapy inherently involves both pulls, one for synchronization (e.g., building rapport and trust) and one for segregation (e.g., challenging the patient). Therefore, a positive correlation between movement and EDA synchrony might not always be expected or even beneficial. Instead, a functional balance, as suggested by Dale et al. (2020), might be more likely. The results, in fact, point in this direction: high movement synchrony paired with low EDA synchrony may be particularly adaptive, suggesting that high synchrony across multiple modalities might not always be beneficial. Moreover, the results support the idea that EDA synchrony may be at least in part independent of movement synchrony (Mayo & Gordon, 2020) as well as that each construct essentially measures something different. Methodologically, the small correlation may be explained by the differing variability within and between therapists in both variables. The ICC values illustrate that there are more consistent patterns of movement synchrony (within-therapists: ICC = .16; between-therapists: ICC = .13), while EDA synchrony is less consistent (within-therapists: ICC = .16) and varies more between therapists (ICC = .23). This might influence the direction and strength of the correlation. EDA synchrony, or rather the ability to tune in to the client emotionally, might be more of a therapist skill and less related to the specific client.

TABLE 3 The effects of within- and between-therapist movement and EDA synchrony on the rate of symptom (STATE) change (Slope).

Predictors	Symptom change			Symptom change			Symptom change		
	Estimates	CI	p	Estimates	CI	p	Estimates	CI	p
(Intercept)	−0.42	−0.55 − −0.28	<.001	−0.43	−0.56 − −0.29	<.001	−0.43	−0.56 − −0.29	<.001
Pre-treatment symptoms	−0.07	−0.11 − −0.03	.001	−0.08	−0.13 − −0.04	<.001	−0.08	−0.13 − −0.04	<.001
Intervention	0.01	−0.05 − 0.06	.7511	0.02	−0.04 − 0.07	.5094	0.02	−0.04 − 0.07	.520
Movement synchrony (varying within-therapists)	−3.84	−7.06 − −0.62	.02	−4.61	−8.04 − −1.18	.008	−4.62	−8.054 − −1.19	.008
Movement synchrony × Intervention	0.07	−2.44 − 2.58	.958	1.37	−1.22 − 3.96	.300	1.36	−1.23 − 3.96	.302
EDA synchrony (varying within-therapists)				−1.29	−8.46 − 5.87	.724	−1.34	−8.52 − 5.85	.715
EDA synchrony × Intervention				5.31	1.05 − 9.56	.015	5.34	1.07 − 9.61	.014
Movement synchrony (varying between-therapists)							−0.35	−2.81 − 2.11	.780
Marginal R^2	.044			.084			.084		
Conditional R^2	.288			.330			.334		

Predictors	Symptom change			Symptom change			Symptom change		
	Estimates	CI	p	Estimates	CI	p	Estimates	CI	p
(Intercept)	−0.43	−0.57 − −0.29	<.001	−0.41	−0.55 − 0.27	<.001	−0.41	−0.55 − 0.27	<.001
Pre-treatment symptoms	−0.08	−0.13 − 0.04	<.001	−0.08	−0.13 − −0.04	<.001	−0.08	−0.13 − −0.04	<.001
Intervention	0.02	−0.04 − 0.07	.519	0.01	−0.04 − 0.06	.741	0.01	−0.04 − 0.06	.741
Movement synchrony (varying within-therapists)	−4.63	−8.06 − −1.19	.008	−3.57	−7.10 − −0.04	.048	−3.57	−7.10 − −0.04	.048
Movement synchrony × Intervention	1.37	−1.22 − 3.97	.298	0.96	−1.65 − 3.57	.471	0.96	−1.65 − 3.57	.471
EDA synchrony (varying within-therapists)	−1.33	−8.51 − 5.85	.716	−3.86	−11.33 − 3.60	.310	−3.86	−11.33 − 3.60	.310
EDA synchrony × Intervention	5.34	1.08 − 9.61	.014	6.44	2.09 − 10.80	.004	6.44	2.09 − 10.80	.004
Movement synchrony (varying between-therapists)	0.34	−2.81 − 2.14	.791	−0.33	−2.80 − 2.14	.763	−0.33	−2.80 − 2.14	.763
EDA synchrony (varying between-therapists)	1.27	−5.25 − 7.80	.702	0.99	−5.48 − 7.47	.763	0.99	−5.48 − 7.47	.763
Movement synchrony × EDA synchrony				61.48	10.74 − 112.22	.018	61.48	10.74 − 112.22	.018
Marginal R^2	.084			.089			.089		
Conditional R^2	.340			.340			.340		

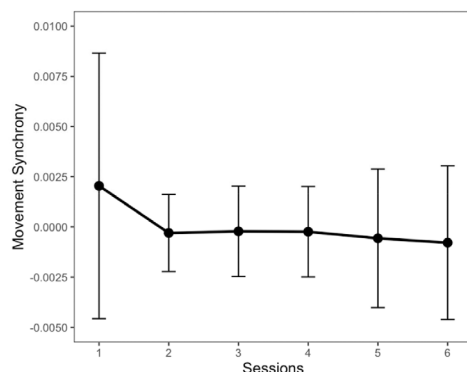
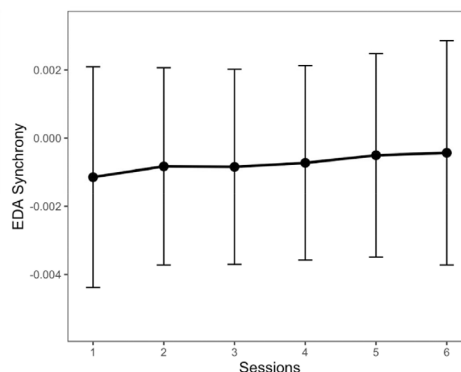
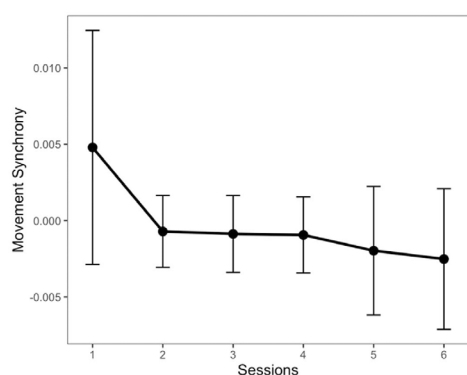
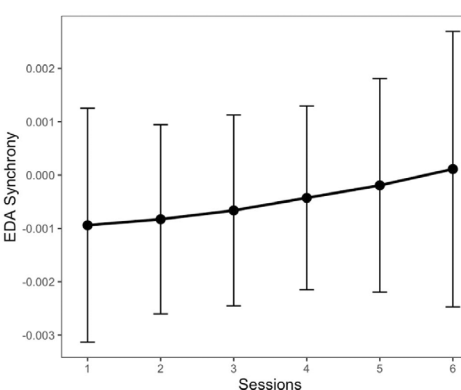
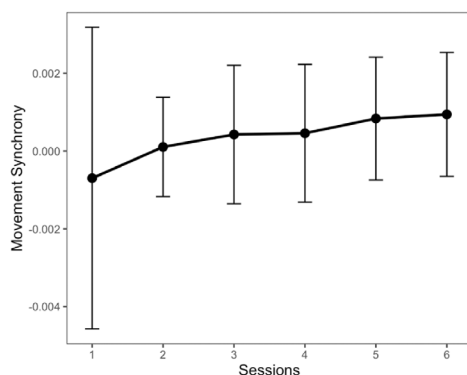
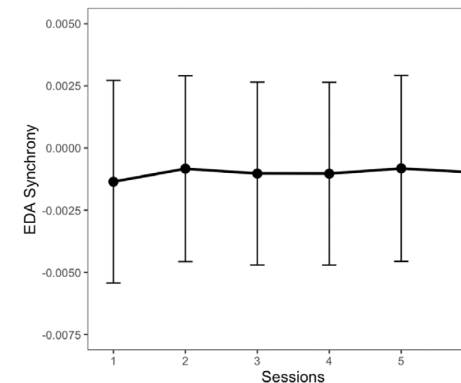
(a) Overall Movement Synchrony**(d)** Overall EDA Synchrony**(b)** Movement Synchrony in Emotion-Focused Interventions**(e)** EDA Synchrony in Emotion-Focused Interventions**(c)** Movement Synchrony in Cognitive Intervention**(f)** EDA Synchrony in Cognitive Interventions

FIGURE 4 Average movement and EDA synchrony across therapists over the course of sessions. (a) Overall movement synchrony. (b) Movement synchrony in emotion-focused interventions. (c) Movement synchrony in cognitive intervention. (d) Overall EDA synchrony. (e) EDA synchrony in emotion-focused interventions. (f) EDA synchrony in cognitive interventions.

The second aim of our study was to explore the predictive power of synchrony in the context of different intervention types, namely emotion-focused and cognitive interventions, within the same sessions. In contrast to our hypothesis, a significant effect on symptom change was only observed for EDA synchrony during cognitive interventions, indicating that less EDA synchrony during cognitive interventions lead to more improvement. This

result seems counterintuitive given previous findings of an association between in-session EDA synchrony in emotion-focused segments (but not cognitive ones) and the therapeutic alliance (Bar-Kalifa et al., 2019) and between average EDA synchrony during emotion-focused segments (but not cognitive ones) and well-being (Prinz et al., 2022). One plausible explanation for the non-significant association between intervention type and

TABLE 4 The Effects of within- and between-therapist movement and EDA synchrony on the rate of symptom (STATE) change (Slope) controlled for outliers.

Predictors	Symptom change		
	Estimates	CI	p
(Intercept)	−0.41	−0.52 – −0.30	<.001
Pre-treatment symptoms	−0.06	−0.10 – −0.03	<.001
Intervention	0.00	−0.04 – 0.05	.938
Movement synchrony (varying within-therapists)	−2.72	−5.80 – 0.35	.082
Movement synchrony × Intervention	−0.36	−1.91 – −2.63	.757
EDA synchrony (varying within-therapists)	−3.67	−10.16 – 2.82	.268
EDA synchrony × Intervention	5.62	1.85–9.39	.003
Movement synchrony (varying between-therapists)	−0.11	−2.21 – 1.99	.920
EDA synchrony (varying between-therapists)	1.40	−3.77 – 6.57	.596
Movement synchrony × EDA synchrony	52.87	8.34–97.40	.020

symptom change could be the fact that in the present study, we averaged synchrony at the therapist and not the client level. Consequently, the focus was shifted away from synchrony as a characteristic of a specific client-therapist dyad, emphasizing it instead as a transtheoretical therapist skill (Atzil-Slonim et al., 2023). Furthermore, this assumption is supported by our findings, which show that 20% of the variance in client's symptom change can be attributed to the therapist effect. From a clinical perspective, the results suggest if therapists experience emotions similar to their clients during cognitive interventions, which usually involve less emotion evocation and processing, this may influence the clients' symptom change in a negative way. This might conflict the therapists' mood-regulatory role (Prinz, Rafaeli, et al., 2021) and therefore, they may be less able to guide the client and stay emotionally stable at the same time (Rogers, 2007). In our sample, the majority of therapists were young ($M=24.80$) and had limited experience (72.73% Master's students). Ramseyer (2020b) suggests that less experienced therapists tend to synchronize more with their clients to avoid dropout as they lack experience in psychotherapeutic processes. As therapists gain more clinical experience, these concerns may diminish, leading to a shift toward a more relaxed attitude regarding a client's decision to pursue therapy or not.

The third aim of the present study was to determine whether individual differences (i.e., between-therapist variability) or within-individual differences (i.e., within-therapist variability) in movement and EDA synchrony would predict symptom change. Interestingly, only the within-therapist variabilities were predictive of symptom change in both synchrony modalities. Specifically, client-therapist dyads marked by generally higher movement and lower EDA synchrony during cognitive interventions relative to the specific therapist were those in which symptoms improved more over the course of treatment.

The results on movement synchrony are in line with several studies showing a positive association between movement synchrony and outcome (e.g., Galbusera et al., 2018; Kupper et al., 2015; Ramseyer & Tschacher, 2011) and seem to indicate that higher synchrony reflects a collaborative stance between client and therapist. For example, Prinz, Boyle, et al. (2021) showed that higher movement synchrony was associated with more in-session mastery. Similarly, Ramseyer and Tschacher (2011) demonstrated that client's self-efficacy ratings positively predicted same session synchrony. If therapists choose to focus on supporting the client to learn coping and problem-solving strategies instead of looking for deeper meaning behind behavior patterns, this may result in an active and engaging interaction, associated with early improvement in test anxiety within a few sessions. This is in line with the additional analysis, showing a general decrease of movement synchrony over the course of treatment. Particularly in the first session, when client and therapist do not yet know each other, the therapist may endeavor to establish a therapeutic relationship through synchronous movements to make the client feel comfortable.

Importantly, movement synchrony was not only predictive of symptom change alone, it also interacted significantly with EDA synchrony. The interaction between movement and EDA synchrony demonstrated that higher movement synchrony was associated with more symptom change, especially in client-therapist dyads with lower EDA synchrony. This opposite pattern can also be found in the average synchrony changes across sessions. While movement synchrony decreased over the course of treatment, EDA synchrony increased. The foundations that are laid at the beginning of treatment utilizing movement synchrony and reflected in high synchrony values may not need to be further developed over the course of treatment. Instead, with the increasingly

complex emotion-focused interventions, more emotions and emotional processing are evoked within the client, automatically leading to a more emotionally involved therapist and an increase in EDA synchrony. These findings are in line with prior research, showing that more synchrony is not generally better. Movement and EDA synchrony are not only capturing different channels of non-verbal behavior, the interplay between both seems to be important as well. As Tal et al. (2023) showed in their single case study, in sessions in which physiological (heart rate) synchrony was high, the association between movement synchrony and therapeutic alliance was not significant. The authors argued that low physiological synchrony may characterize more engaging conversations, whereas high physiological synchrony indicates less active contexts. Clinically, this could mean that if therapists move with similar frequency (indicating high movement synchrony) and simultaneously remain emotionally stable (indicated by low EDA synchrony), they are better able to guide the client.

4.1 | Strengths, limitations, and future directions

The current study contributes to the existing literature on synchrony by filling several gaps: First, to our knowledge, this was the first study to examine movement and EDA synchrony at the same time to gain a more comprehensive understanding of the therapeutic processes at work. Second, this was also the first study (to our knowledge) examining movement and EDA synchrony as putative predictors on two different levels by taking variability within and between therapists into account.

Despite the study's strengths, some shortcomings are notable. The inclusion criterion of therapists treating three or more clients is relatively liberal and the limited number of therapists ($N = 22$) is rather small. As a result, the extent and direction of synchrony may have been influenced. Although these small numbers are a common phenomenon associated with routine care data sets, they can lead to an overestimation of the therapist effect and must be interpreted with caution. Furthermore, while the homogeneity of the sample in terms of age ($M = 24.80$ years) and experience (72.73% Master's students) may have advantages, it could potentially impact the generalizability of the findings. Replication and extension studies would be needed before generalizing the conclusions to other client populations or even clients with test anxiety treated with other protocols. In addition, a larger and more diverse sample with more clients per therapist would provide a more comprehensive foundation upon which to draw conclusions. A

further limitation is the exploratory nature of the study. Specifically potential bias may have been introduced using point estimates from a hierarchical linear model as outcome variables in separate multiple regression models. This generated regression bias is problematic as uncertainty regarding the parameters' estimates is disregarded in the following models.

The information available on the therapists was limited. Aside from age, gender, and experience, there is little knowledge about other relevant characteristics, such as attachment styles. This limitation may potentially restrict a more in-depth analysis of therapist-related factors that could have influenced the outcomes.

Furthermore, the STATE-TA is a measure for symptom change consisting of only two items. Due to the small number of items, the complex structure of test anxiety can only be captured to a limited extent. Aspects regarding evaluation apprehension as well as low efficacy are not taken into account. Despite the STATE-TA's good internal consistency ($\alpha = .86$) as well as its time and cost efficiency, the results must be interpreted with caution. Another limitation is the use of imagery work as an emotion-focused intervention. During imagery work, the client closed his/her eyes, and the therapist was free to do so. Therefore, only one of the two partners received visual cues, which could have possibly influenced movement synchronization. This can be seen in the additional analyses of leading and pacing. However, the intervention was not a significant predictor of symptom change.

The results of this study have implications that demand closer examination and further investigation. Future studies should investigate the causes and effects of the associations to gain a deeper understanding of the interplay between these two constructs. For instance, future work could benefit from investigating the effects of leading and pacing synchrony, as they could potentially serve as moderating factors and provide explanations of the heterogeneity in existing findings.

5 | CONCLUSIONS

The present study emphasized the importance of investigating synchrony effects both within and between therapists. Movement and EDA synchrony differ in their variability and show only a small negative correlation. Furthermore, both synchrony modalities were predictive of clients' symptom change on the within-therapist level. Higher levels of movement and lower levels of EDA synchrony in the treatment of an individual client were found to be associated with clients' change rates. Integrating these findings into clinical training programs could be beneficial. By acknowledging the significant impact therapists

have on client outcomes, training programs can prioritize the development of skills that facilitate effective therapeutic engagement and synchronization. Additionally, to provide therapists with information on their average synchrony values, synchrony could be integrated into a comprehensive feedback system (Lutz et al., 2021) to help increase therapists' awareness of non-verbal processes.

AUTHOR CONTRIBUTIONS

Jessica Uhl: Conceptualization; data curation; formal analysis; investigation; methodology; project administration; writing – original draft. **Uwe Altmann:** Conceptualization; formal analysis; methodology; writing – review and editing. **Eshkol Rafaeli:** Project administration; resources; supervision; writing – review and editing. **Patrick Bungart:** Data curation; formal analysis; writing – original draft. **Wolfgang Lutz:** Funding acquisition; project administration; resources; supervision; writing – review and editing.

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The protocol of this study was published in Prinz et al. (2016) and Prinz et al. (2019). Part of the data analyzed in this study were published in Bar-Kalifa et al. (2019), Prinz, Rafaeli, et al. (2021), Prinz et al. (2022), and Uhl et al. (2023). Bar-Kalifa et al. (2019) examined the association between EDA synchrony and therapeutic alliance based on 31 client-therapist dyads in emotion-focused versus cognitive interventions. Prinz, Rafaeli, et al. (2021) investigated associations between client-led and therapist-led EDA synchrony and in-session emotional experience during imagery rescripting using actor-partner interdependence models. The analysis was based on 50 client-therapist dyads and emotional experience was assessed using the Profile of Mood States. Prinz et al. (2022) tested whether client EDA arousal and client-therapist EDA synchrony during imagery rescripting predicted next-session outcome (Outcome Rating Scale) and overall treatment response (Test Anxiety Inventory) and compared the findings to EDA arousal and EDA synchrony during cognitive interventions. The analysis was based on 60 client-therapist dyads. Uhl et al. (2023) investigated the association between EDA synchrony and emotional processing based on 50 client-therapist dyads. These four previous studies differ from the present study in several aspects: (a) Sample: The previous studies examined only specific sessions of a subset of client-therapist dyads. This is the first study to examine all six sessions; (b) EDA synchrony: The previous studies averaged synchrony at the client level, while the present study examines the therapist level, (c) Movement synchrony: None of the previous studies investigated movement synchrony,

(d) Outcome measures: None of the studies predicted the same outcome measures.

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CONFLICT OF INTEREST STATEMENT

We have no conflict of interest to disclose.

DATA AVAILABILITY STATEMENT

The data sets analyzed in the current study are available from the corresponding author on reasonable request.

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