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Coregulation of therapist and client emotion during psychotherapy

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Abstract

Close interpersonal relationships are fundamental to emotion regulation. Clinical theory suggests that one role of therapists in psychotherapy is to help clients regulate emotions, however, if and how clients and therapists serve to regulate each other's emotions has not been empirically tested. Emotion coregulation - the bidirectional emotional linkage of two people that promotes emotional stability – is a specific, temporal process that provides a framework for testing the way in which therapists' and clients' emotions may be related on a moment to moment basis in clinically relevant ways. Utilizing 227 audio recordings from a relationally oriented treatment (Motivational Interviewing), we estimated continuous values of vocally encoded emotional arousal via mean fundamental frequency (f_0). We used dynamic systems models to examine emotional coregulation, and tested the hypothesis that each individual's emotional arousal would be significantly associated with fluctuations in the other's emotional state over the course of a psychotherapy session. Results indicated that when clients became more emotionally labile over the course of the session, therapists became less so. When changes in therapist arousal increased, the client's tendency to become more aroused during session slowed. Alternatively, when changes in client arousal increased, the therapist's tendency to become less aroused slowed.

Keywords

dynamic systems; emotion coregulation; psychotherapy; therapeutic relationship

Psychotherapy represents a class of treatments for mental health and substance abuse problems, the foundation of which is the interaction between the therapist and client. A number of components of the therapeutic relationship are associated with the success of psychotherapy (Norcross & Lambert, 2011), and outside the context of psychotherapy there is broad evidence for the importance of close relationships for overall health and wellbeing

(e.g., Reblin & Uchino, 2008). A particular focus of research in close relationships has been to explore how partners help each other manage their emotional experiences (i.e., coregulation; Butler & Randall, 2013). Thus, one possible role of the therapist is to provide an interpersonal relationship which helps the client to regulate their emotions. The purpose of this study was to examine if and how therapists may serve this regulatory function during a psychotherapy session.

While some active ingredients of the therapeutic process (e.g., behavioral activation) may not be explicitly interpersonal, most depend on some form of interpersonal interaction for administration. Some treatments, such as Motivational Interviewing, are explicit in their reliance on features of the therapeutic relationship (e.g., collaboration, non-judgment; Miller & Rollnick, 2012), while other treatments hold that positive interactions between the patient and therapist are necessary to perform other techniques that are responsible for improvement (e.g., Cognitive Therapy; Beck, Rush, Shaw & Emery, 1979). There are numerous models and measures of the therapeutic relationship in psychotherapy (e.g., working alliance, real relationship, therapist empathy, congruence, etc.), which are among the most studied phenomenon in psychotherapy and strongly correlated with positive therapeutic outcomes (r = 0.30; Elliott, Bohart, Watson, & Greenberg, 2011; Horvath, Del Re, Flückiger, & Symonds, 2011; Norcross & Lambert, 2011). The way the therapist and client navigate the emotional landscape of the therapy interaction is also thought to be a core feature of the therapeutic relationship (Greenberg & Safran, 1989), particularly the human bond that develops between therapist and client (Bordin, 1979; Gelso, 2014). However, there has been little empirical work on how the therapist may help the client regulate their emotions during a session.

Emotion Regulation in Psychotherapy

Emotion regulation refers to a diverse set of psychological processes by which emotions are amplified, reduced, or maintained (Gross, 1998; Gratz, Weiss, & Tull, 2015). One particular function of emotion regulation is facilitation of homeostasis, which refers to returning to the resting level of arousal in an emotional system following excitation or inhibition. Here, research on emotion regulation is primarily concerned with factors that influence the rate of return to the average level of emotional arousal (i.e., the set point; see Baucom et al., 2012). The set point acts as an individual's baseline level of arousal, a point from which the individual deviates, and continues to return towards after becoming aroused (Butler & Randall, 2013). The ability to return to an emotional set point is a crucial process for life long social and physical well-being (e.g., Eisenberg, Fabes, Guthrie, & Reiser, 2000; John & Gross, 2004), and there is broad evidence that problems with emotion regulation are involved in different forms of psychopathology (e.g., Casey, Rogers, Burns, & Yiend, 2013). Many evidence based treatments focus on training clients to use skills that may help regulate their emotions (e.g., mindfulness; Chambers, Gullone, & Allen, 2009), for instance, encouraging clients to acknowledge and process negative emotions (for a review see Thompson, 2011). Perceived emotion regulation is associated with the working alliance and outcomes (Watson, McMullen, Prosser, & Bedard, 2011). For instance, those clients receiving cognitive therapy, with and without pharmacology, showed significant improvement in the presence of a strong therapeutic alliance and deeper emotional

experience (Castonguay, Goldfried, Wiser, Raue, & Hayes, 1996). Further, another study demonstrated clients whose depressive symptoms significantly improved while receiving cognitive therapy experienced more depth in their emotional process as compared to clients whose symptoms did not significantly improve (Watson & Bedard, 2006). However, the bulk of studies have relied on assessing emotion regulation through self- and observer-report, and have not tested dynamic patterns of how clients regular their emotions during treatment interactions.

Client emotion regulation can be both within person experiences, behaviors, and physiology (i.e., intrapersonal; Thompson, 2011), as well as shared components of emotional states across people (i.e., interpersonal; Butler, 2011). Emotion regulation and treatment research has mostly focused on these intrapersonal emotional regulation strategies. There is a parallel line of research emerging from emotion science and social psychology that suggests interpersonal relationships are a default way that individuals regulate their emotions (e.g., parent-infant dyads; Feldman, 2003; romantic relationships; Butner, Diamond, & Hicks, 2007). Emotion coregulation refers to the idea that regulation is impacted not only by an individual's own internal emotional state, but also by the emotional states of other people with whom the individual is interacting (see Butler & Randall, 2013 for a review in social psychology; see also Beckes, & Coan, 2011 on social baseline theory).

Psychotherapy is a particular form of a close, emotion laden interpersonal relationship with the explicit goal of one individual influencing the psychological well-being of another. Thus, we might expect that a therapist's emotional responses may be directly involved in how the client regulates their own emotional experience during the interaction. For example, Hayes, Laurenceau, Feldman, Strauss, and Cardaciotto (2007) proposed that emotional changes during therapy may include disruptions in the client's typical emotional process as they work through difficult issues. They suggest that that emotion during psychotherapy functions as a feedback loop where more extreme levels of emotion in one individual are pulled back towards an average level of emotion by the other partner. There is also a substantial theoretical literature on the importance of the therapist providing the "holding environment," which may allow clients to reach arousal levels that they may be avoiding (Winnicott, 1963; Modell, 1976; Slochowder, 1991), and potentially for the client to regulate their arousal back to their set point. In Motivational Interviewing, a therapist is charged with responding with empathy and compassion to clients who are struggling with behavior change. Consider a client who is frustrated with not being able to quit using alcohol. As the client begins to delve into the chaos that has resulted from losing a job or relationship they are likely to become more emotionally aroused. The way a therapist responds to this emotional display may help the client temper a tendency towards becoming too aroused.

In contrast, it is also possible that client emotion will have an impact on the therapist's emotions. Given basic psychological processes like emotional contagion (Hatfield, Cacioppo, & Rapson, 1994), it would seem likely that sitting with a client who is highly anxious or very sad would pull a therapist in that emotional direction. Additionally, the therapist may relate to the emotional experiences of the client in a personal way (Dahl et al., 2014), and influence the therapist's decisions and interventions (i.e., countertransference; Dahl, Røssberg, Bøgwald, Gabbard, & Høgland, 2012). In sum, current theory and clinical

intuition suggest that there are at least two emotional tasks therapist may engage in during psychotherapy: 1) respond to a client in a way that helps them to manage their emotional arousal, and 2) manage a complementary pull from clients that may lead the therapist to become more emotionally aroused during the session.

The general proposition that clients and therapists coregulate one another's emotions is consistent with work demonstrating interpersonal synchrony in therapy dyads. For example, greater synchrony of skin conductance (a measure of emotional arousal) was correlated with higher observer rated empathy (Marci, Ham, Moran, & Orr, 2007; Robinson, Herman, & Kaplan, 1982; Dimascio, Boyd, & Greenblatt, 1957), and therapists who match their vocally encoded emotional arousal to that of the client were perceived as more empathic by the client and by objective observers (Imel et al., 2014; Weiste & Peräkylä, 2014; for one exception see Reich, Berman, Dale, & Levitt, 2014 where higher synchrony in vocal arousal was related to poorer client outcomes). Additionally, Bryan et al. (2018) found evidence of moment to moment mutual influence of therapist and client emotional arousal. The degree of mutual influence was positively related to a deeper emotional bond during crisis intervention (Bryan et al., 2018). However, specific intra- and interpersonal patterns of how patients and therapists leave and return to an emotional set point (i.e., regulate their emotional experience) have not yet been examined. How clients regulate their emotion during a session, specifically the degree to which they demonstrate a pattern of leaving and returning to their set point and the ways that a therapist is involved in those processes is unclear.

The ways in which clinically relevant regulatory and coregulatory processes might emerge in psychotherapy could vary across presenting problems, therapeutic orientations, and clinical roles. Given differences between therapists and clients in their roles, and training, it would be logical to expect individual differences in both intra- and interpersonal patterns of emotional expression, and how they might influence their partner. To continue the substance abuse example from above, we might expect the client to become more aroused throughout session as they get deeper into their problems. One possible goal of the therapist in this situation would be to respond in a way that helps contain this increasing arousal. In contrast, in a treatment like Prolonged Exposure (e.g., Foa, 2011) for PTSD, a client with high levels of avoidance might have a tendency to not become more aroused during a session, and the goal of the therapist might be to actually increase client arousal. Yet, the therapist might attempt to maintain a state of calm throughout the session even if a client is becoming distressed. Indeed, there is evidence that therapist (as compared to non-therapists) return to their baseline more quickly after a negative emotional stimulus (Pletzer, Sanchez, & Scheibe, 2015). However, before moving to test differential predictions about specific clinically relevant forms of intra and interpersonal and coregulation, it is first necessary to test the fundamental proposition that emotion coregulation occurs between therapists and clients during psychotherapy.

Current Study

The current study represents an initial test of client and therapist emotion coregulation in psychotherapy. We examined a collection of 227 Motivational Interviewing sessions, and

16,355 repeated observations of vocal encoded emotional arousal (i.e., fundamental frequency, a standard measure of emotional arousal, see below; Juslin & Scherer, 2005). To separate intrapersonal and interpersonal patterns of regulation (described above) over time in the session, we used a dynamic systems framework (Butner et al., 2007; Helm Sbarra, & Ferrer, 2012). Dynamic Systems models allow an exploration of changes in how far individuals deviate from, and how quickly they return to a given set point of emotional arousal; a process quantified through acceleration (defined and described below). While we examined intra-personal regulation patterns by predicting acceleration, our primary hypothesis was that both therapist (H1a) and client (H1b) emotional arousal would have an impact on the other's pattern of emotion regulation over the course of the session.

Method

Data Source

Participants.—The sample was 227 sessions from an MI training study of six MI dissemination trials (Baer et al., 2009; Lee et al., 2014; Roy-Byrne et al., 2014; Lee et al., 2013; Neighbors et al., 2012; Tollison et al., 2008)[1]. The trials included 108 therapists, who conducted brief substance use focused sessions, and there is only one observation of a given client-therapist dyad. Therapists saw an average of 2.10 clients ($SD = 2.13$), ranging from therapists who saw one client to a therapist who saw 12 clients. The primary nesting group was session, and data was thus nested within sessions.

Motivational Interviewing Studies.—The six trials included therapists who underwent MI training and received continued weekly supervision (Lee et al., 2014; Lee et al., 2013; Neighbors et al., 2012; Tollison et al., 2008), therapists who received initial training, were monitored, and notified of drift from MI protocol (Roy-Byrne et al., 2014), and therapists who had received training without continued supervision (Baer et al., 2009). One study was a clinical trial with patients and providers in a primary care setting, that compared brief alcohol and drug interventions versus enhanced care (Roy-Byrne et al., 2014). Four of the studies focused on alcohol and marijuana use in college students (Lee et al., 2014; Lee et al., 2013; Neighbors et al., 2012; Tollison et al., 2008). The final study took place in community based primary care clinics in which patients may have been using many types of drugs at one time (Baer et al., 2009). The trials were conducted in the Pacific-Northwest and were approved through the University of Washington IRB.

The primary treatment modality in each study was MI, an empirically supported psychotherapy, originally developed to treat individuals struggling with substance abuse, and has since been expanded with many populations (e.g., weight loss; Armstrong et al, 2011), and in many different settings (e.g., mental health, primary care; Lundahl, Kunz, Brownell, Tollefson, & Burke, 2013). At its theoretical core, MI emphasizes the therapist's ability to accurately understands, or makes efforts to understand, a client's experience (i.e., empathy) and specifies that the therapist use a specific type of language (e.g., reflective statements) focused on eliciting client motivated change. Client verbal statements regarding behavior

[1]We conducted a sensitivity analysis with site as a fixed effect covariate; results indicated no significant differences between sites.

changes (i.e., change talk) are theorized to motivate further behavior changes (Miller & Rollnick, 2012).

Measures

Emotional Arousal: Vocal fundamental frequency (f_0)**.—**Client and therapist emotional arousal were assessed with mean f_0, a well validated and minimally invasive measure of vocally encoded emotional arousal (Juslin & Scherer, 2005). F_0 is the vibration generated through the vocal folds in the throat, and corresponds to the lowest harmonic produced during speech. Higher mean f_0 is commonly perceived as higher pitch, and is highly correlated with other measures of physiological and self-reported emotional arousal (Juslin & Scherer, 2005). Vocal acoustics are a primary vehicle for affective information (Juslin & Scherer, 2005) and provide one way individuals ascertain affect in social situations in order to engage in effective social communication (Lima, Castro, & Scott, 2013). Vocal tone is associated with the quality of social relationships, medical care, and effective communication (Laukka et al., 2008). It is also a meaningful predictor of psychological and relational phenomenon (e.g., empathy and divorce among couples; Weusthoff, Baucom, & Hahlweg, 2013). Though emotional experience has been demonstrated to be two dimensional – including both arousal and valence – (Posner, Russell, & Peterson, 2005), we measured arousal due to the nature and quality of the data.

To extract f_0 estimates that were aligned with speaker role (therapist vs. client), we only utilized sessions that had been manually transcribed and time stamped to ensured that f_0 estimates are linked to the appropriate speaker (see Xiao, Imel, Atkins, Georgiou, & Narayanan, 2015 for additional technical information). Mean f_0 was extracted using *Praat,* a standard speech signal processing software package (Boersma & Weenink, 2009), and a bandpass filter of 75 to 350 Hz to ensure values were consistent with the typical range of pitch for adult human speech (Boersma & Weenink, 2009). We generated speaker-specific f_0 values at each quarter second interval (Liebenthal, Silbersweig, & Stern, 2016). The 227 sessions, there were 1,207,282 quarter second estimates of f_0 across 16,355 talk turns (M = 36.52 talk turns per session, SD = 17.76). The statistical model, described below, required the average of these quarter second intervals over three talk turns (n = 16,355) to properly calculate velocity and acceleration (refer to Appendix A for further information on smoothing of f_0 estimates).

Statistical Analysis

Dynamic systems models are particularly well-suited to modeling coregulation of therapists' and clients' emotional arousal in a psychotherapy session[2] because they can be used to characterize changes in client and therapist emotional arousal over time, how quickly the client and therapist are becoming emotionally aroused, and how quickly they are returning to their average level of arousal; a process we are quantifying with a variable called *Acceleration*. Acceleration is quantitatively defined as the difference between two

[2]See Gelo, & Salvatore (2016) for a theoretical description of dynamic systems and applications to psychotherapy research.

consecutive changes in emotional arousal (i.e., *velocity*), and qualitatively describes how quickly the individual returns to a level of emotional arousal (see Appendix A for details on acceleration calculations). All calculations and modeling were done with *R* version 3.3.2, an open source statistical software, using the *lme4* package (Bates, Mächler, Bolker, & Walker, 2014).

The dynamic system models described below are a specific form of the Actor-Partner Interdependence Model (APIM) which are useful in characterizing mutual influence in dyadic contexts. Actor effects describe the effect of the individual on themselves (e.g., the effect of prior arousal on current arousal), and partner effects describe the relationship between the individual's own arousal and their partner's arousal (Kivlighan, Marmarosh & Hilsenroth, 2014; Kenny, Kashy & Cook, 2006). A client, for instance, influences themselves (actor effect), as well as their therapist (partner effect). In the current study, the client's expression of affect via fundamental frequency may impact their later expression in the session and also the therapist emotional expression during the session. Similarly, the therapist influences themselves and the client, and their actions affect how they experience the session and how the client experiences session (Kenny, Kashy & Cook, 2006).

Coupled Linear Oscillator Dynamic Systems Model.—One particular dynamic systems model, the coupled linear oscillator (CLO), specifically maps onto the concept of coregulation outlined in the introduction because it models how quickly variable return to set points following displacement (e.g., Felmlee & Greenberg, 1999; Deboeck et al., 2008). CLO models translate the conceptual assumptions of coregulation into three sets of model parameters: 1) emotional set points (i.e., the level of emotional arousal that the person would return to in the absence of responding to an event), 2) intrapersonal regulatory parameters (i.e., how quickly the person returns to set point independent of the other person's emotional state), and 3) interpersonal coregulatory parameters (i.e., how quickly the person returns to set point depending on the other's emotional state). In CLO models, patterns of emotion regulation are operationalized as variability in $Acceleration$ over time, or the degree to which a therapist or client is returning to their emotional set point. The equation takes emotional arousal $Level$ and $Velocity$ as predictors of $Acceleration$, and is as follows in equation (1):

$$Acceleration_{tij} = b_{0i_{a|p}}(Level_t) + b_{1i_{a|p}}(Velocity_t) + u_j + \epsilon_t \quad (1)$$

The outcome $Acceleration_{tij}$ represents the predicted *acceleration* at time t for dyad member i (therapist or client) in session j. $Level_t$ is the mean f_0 value and indexes how aroused a partner was in a given time t regardless of how fast they were changing. $Velocity_t$ is the rate of change or the slope of arousal regardless of how aroused they may be in a given moment in time (see Appendix A for details on calculation of level, velocity, and acceleration).

Coregulation is represented by both intra (actor) and interpersonal (partner) effects for level and velocity. The a or p subscripts denote whether a parameter represents the effect of the self or the other person's f_0 value (i.e., '*a*'ctor or '*p*'artner effects) where the pipe symbol (|) is read as 'or'.

Level.—The parameter b_{0i} quantifies the effect of arousal *Level* on *Acceleration* – essentially how frequently individual *i* (therapist or client) becomes aroused, regulates, and becomes aroused again (i.e., oscillation frequency). For example, b_{0i_a}(i.e., the actor effect for *Level*) characterizes if and how frequently person *i* oscillates around their set point of emotional arousal and thus provides a test of *intrapersonal* regulation – does either the therapist or client tend to begin returning to their set point of emotional arousal when they are further displaced from that set point. A negative b_{0i_a} would indicate that a person begins to return to their set point of emotional arousal faster when they are farther away from the set point. This effect is depicted by the patterns in both Figures 1a and 1b, and suggests a process of regulation wherein the therapist is repeatedly leaving and returning to their set point. The parameter for b_{0i_p} (i.e., partner effect for *Level*) describes the effect of the partner's level of arousal on the other individual's *Acceleration*, and thus how the partner's level of arousal impacts how quickly the actor is regulating their arousal (i.e., leaving and returning to their set point).

Velocity.—The parameter b_{1i} quantifies the impact of *Velocity* on *Acceleration* and provides a test of whether peak levels of arousal change over time. For example, in Figure 1a b_{1i_a} (the actor effect on velocity) is negative. The pattern of arousal might depict a therapist or client starting at higher maximum levels of arousal, and gradually decreasing to a lower level of arousal over time. Alternatively, in Figure 1b, b_{1i_a} (i.e., the partner effect on velocity) is positive and shows a lower level of arousal gradually increasing to a higher level of arousal.

Partner effects of *Velocity* characterize the *interpersonal* amplification or dampening of within person changes in emotional arousal over the session – essentially whether the therapist or client has an impact on their partner's tendency to increase or decrease their maximum emotional arousal over the session. Specifically, the partner effect of *Velocity*, b_{1i_p}, describes how the partner's change in emotional arousal influenced how quickly the other individual was leaving or returning to their set point of emotional arousal. If say b_{1i_p} is negative for the client *Acceleration*, this would indicate that when the therapist is increasing their emotional arousal, the client's peak arousal would tend be become relatively less extreme over the session. Alternatively, if b_{1i_p} is positive, the effect of the client becoming more emotionally aroused would be a relative increase in the therapist's maximum emotional arousal over time.

Taken together, the combination of actor and partner effects indicate whether a client or therapist is emotionally ramping up or calming down throughout a session, and whether their compatriot is amplifying or attenuating that trajectory.

Results

Across the 227 sessions and 16,355 repeated observations, the mean f_0 for therapists was 159.03 hertz (*SD* = 29.49), and 146.25 hertz (*SD* = 31.30) for clients. Person-centering f_0 estimates for each member of the dyad served to eliminate anatomically-determined, mean

level gender differences in f_0. We describe results in two sections, first focusing on characterizing patterns of emotional arousal for the client, and then for the therapist. In each case, we begin with preliminary analyses that tested the pattern of *intrapersonal* regulation (actor effects) – whether the client or therapist demonstrated a regulatory pattern such that they repeatedly left and returned to their set point over time in the session, and whether their maximum level of emotional arousal increased or decreased over time. Next, we tested our primary hypothesis regarding *interpersonal* regulation (partner effects) – whether or not, and consequentially how, the therapist or client influenced their respective partner's pattern of emotional arousal.

Effects on Client

Intrapersonal Regulation.—The effect of client's level of emotional arousal on their own acceleration (i.e., actor effect of emotional arousal level) was negative and significant, $b_{0Client_a} = -0.79$, $t(226) = -38.46$, $p < 0.0001$, 95% CI [−0.82, −0.74], such that as level increased, acceleration decreased. This effect suggests that as a client moved further away from their set point, their movement away from that set point slowed. Essentially, this effect was consistent with a process by which the client was regulating their own emotional arousal. The effect of client's velocity on their own acceleration (i.e., actor effect of velocity) was positive and significant, $b_{1Client_a} = 0.76$, $t(226) = 117.52$, $p < 0.0001$, 95% CI [0.75, 0.77], indicating that the client's maximum levels of emotional arousal were increasing over the course of the session. This pattern of findings suggests that the client was showing a regulatory pattern where they repeatedly returned to a set point, but the distance from which they deviated from that set point before returning increased over the session.

Interpersonal Regulation.—Consistent with our primary hypothesis, therapist emotional arousal impacted client emotional arousal. The effect of therapist's emotional arousal level on client's acceleration (i.e., the partner effect of emotional arousal level) was negative and significant, $b_{0Client_p} = -0.06$, $t(226) = -2.84$, $p < 0.001$, 95% CI [−0.10, −0.02]. This indicated that when the therapist was at a higher level of arousal the client returned to their set point more quickly.

In addition, the effect of therapist's change in emotional arousal on client acceleration (i.e., partner effect of emotional arousal velocity) was negative and significant, $b_{1Client_p} = -0.03$, $t(226) = -4.10$, $p < 0.0001$, 95% CI [−0.04, −0.02]). That is, when the therapist arousal increased, the client tended to return to their arousal set point more quickly.

In sum, these finding suggest that while the general pattern of the client was to increase their maximum arousal over the course of the session, when therapist's change in emotional arousal was positive, these increases were constricted. That is, when the therapist is increasing their arousal, the client's maximum emotional arousal lessened over time.

Effects on Therapist

Intrapersonal Regulation.—The effect of the therapist's level of emotional arousal on their own acceleration (i.e., actor effect of emotional arousal level) was significant and

negative, $b_{0Therapist_a}$ = −0.78, $t(226)$ = −34.84, p < 0.0001, 95% CI [−0.82, −0.74]. As with the client, a negative value indicated that the therapist returned to their set point more quickly over time. In contrast to the client effects above, the effect of the therapist's change in emotional arousal (i.e., actor effect of velocity) on acceleration was significant and negative, $b_{1Therapist_a}$ = −0.75, $t(226)$ = −106.17, p < 0.0001, 95% CI [−0.77, −0.74]). This indicates that the therapist's maximum arousal decreased over the course of a session.

Interpersonal Regulation.—Consistent with our primary hypothesis and with the effect of the client on the therapist noted above, the client's level of emotional arousal (i.e., partner effect of emotional arousal level) significantly and negatively predicted therapist's acceleration, $b_{0Therapist_p}$ = −0.05, $t(226)$ = −2.66, p < 0.001, 95% CI [−0.091, −0.020]. Thus, when the client was at a higher level of arousal the therapist tended to return to their arousal set point more quickly.

However, in contrast with the constricting effect that therapist arousal had on the client's pattern of increasing arousal over time, the effect of client's change in emotional arousal on therapist acceleration (i.e., partner effect of emotional arousal velocity) was positive and significant, $b_{1Therapist_p}$ = 0.03, $t(226)$ = 4.30, p < 0.0001, 95% CI [0.02, 0.04]. In contrast to the client, the therapist generally decreased their maximum level of emotional arousal over the sessions. However, when the client changes in arousal were positive, this decrease was attenuated.

Discussion

This study utilized dynamic systems models to explore if, and how, therapists and clients regulate and coregulate their emotional arousal during psychotherapy sessions. Therapists and clients demonstrated both intrapersonal and interpersonal patterns of arousal. Specifically, both parties leave and return to an emotional set point, and their partner's expressed arousal influenced that trajectory. This evidence is consistent with early findings regarding social emotional processes occurring during psychotherapy (e.g., Robinson et al., 1982; Dimascio et al., 1957). Though fitting under the broad umbrella of mutual influence, the current demonstration of coregulation extends beyond just synchrony (e.g., Imel et al., 2014), mirroring (e.g., Marci et al., 2007), or a covariance of emotion during a mutually shared experience (e.g., Saxbe & Repetti, 2010). That is, current findings demonstrate a moment to moment bidirectional linkage of therapist and client emotional experience (see Peluso et al., 2012 for a simulated example of this process), which may provide useful clinical insights.

For both therapist and client, there was evidence of an intrapersonal (within person) oscillatory pattern where both become emotionally aroused, reach a maximum arousal level, and return to an emotional set point. This finding of within session intrapersonal emotion regulation has been discussed in other domains by Butler and Randall (2013), and demonstrated with romantic couples' self-reported emotions (Butner, Diamond, & Hicks, 2007) and observations of couples' heart rates (Helm, Sbarra, & Ferrer, 2012). This pattern suggests that regardless of the interpersonal dynamics that may influence the emotional

experience of clients and therapists, both are utilizing internal resources to manage their arousal during a session.

However, the way in which these within person patterns emerge over time differed in ways that are consistent with the roles of a client and therapist. The therapist's arousal started high and decreased during session, and the client's arousal started low and increased. Perhaps higher therapist arousal at the beginning of session may relate to therapist activation and engagement, demonstrating presence and openness to client experiences (i.e., therapeutic presence), which may help the client feel safe (Geller & Porges, 2014), and thus begin to engage the client in therapy. As session progresses, however, the therapist might become less emotionally activated to provide the client space (Levitt, 2002) or to help ground the client. In contrast to therapists, clients began at a lower emotional arousal and increased throughout session. Clients may require time to delve into therapeutic content, and as therapy is more emotional or difficult client arousal may continue to increase (e.g., Pos, Greenberg, Goldman & Korman, 2003). Therapists may facilitate an increase in arousal with a variety of interventions, ranging from making reflective statements (e.g., Motivational Interviewing), utilizing silence (Levitt, 2001), to explicitly asking clients about their emotional experience (e.g., Greenberg, 2015).

The intrapersonal regulatory processes described above are complimented by evidence suggesting that the emotional arousal of their partner influences changes in moment to moment emotional expression. Both clients and therapists changed their emotional expression after high levels of arousal in their partner in a manner that mirrored interpersonal regulatory processes; that is, they responded to high levels of arousal from a partner by returning back to their set point more quickly. Just as individual's experience high levels arousal tend to respond to extremes in their own emotional expression by returning to a set point, they may experience extremes in their partner's emotion as cues to regulate their own expression, facilitating the individual's return to a more moderate level of arousal (e.g., Aragón, Clark, Dyer, & Bargh, 2015).

On the contrary, the way therapist and client changes in emotional arousal impacted their partners differed. Clients tended to become less aroused over time when their therapist increased their arousal. It is possible that this pattern indicates that the client felt safer when therapist was active and engaged (Geller & Porges, 2014), thus decreasing their emotional arousal. The broad pattern of the therapist helping the client to constrain their emotional arousal is consistent with the creation a "holding environment" for the client (Winnicott, 1963). Research has investigated an analogous physiological phenomenon in dyadic relationships, demonstrating individual tolerance to physical pain is higher in the presence of another person (Coan, Schaefer, & Davidson, 2006). Perhaps, one way this process may occur in psychotherapy is that the client is able to regulate more effectively when they sense that the therapist emotional engaged and responding to their emotional distress. For example, the experience of hearing others attempts to understand may reduce negative, and increase positive emotion (Seehausen et al., 2012; Morelli, Torre, & Eisenberger, 2014).

In contrast with the effects of the therapist on the client, client increases in arousal where associated the therapist becoming more aroused over time. There are a number of possible

drivers of this phenomenon in psychotherapy. The context of therapy may provide the client space to express particularly painful emotions (Pascual-Leone & Greenberg, 2007), thus potentially pulling the therapist into a more emotional space – via processes like emotional contagion (cite). As a cornerstone of Motivational Interviewing (the primary treatment utilized in the current study), empathy may involve the therapist experiencing a representation of the client's emotional experience (Miller & Rollnick, 2012; Preston & De waal, 2002). However, the effect of a client increasing therapist arousal might appropriately raise concerns about emotional fatigue, which may be a primary cause of therapist burnout (i.e., compassion fatigue; Figley, 2002). Pronounced emotional reactions to client emotion could be understand as a form of countertransference (Dahl, Røssberg, Bøgwald, Gabbard, & Høgland, 2012), and could be important targets for supervision and consultation. Modern psychodynamic theory highlights the potential utility of therapists using the emotional impact their clients have on them to promote insight (Winnicott, 1949).

Limitation and Future Directions

As noted above, there are a number of ways in which coregulatory effects might be used to understand specific dyadic processes in psychotherapy. However, the current demonstration of coregulation in psychotherapy did not evaluate what specific processes might be beneficial to clients. Future work should examine potential effects of coregulation on other aspects of process and treatment outcome. For example, Modell (1976) hypothesized about the function of the "holding environment" (see also Winnicott, 1963), where the therapist is to be reliable, and less-judgmental, providing a relational context that allows the client to tolerate distressing emotions. It is possible that one way in which the 'holding environment' works is via the therapist providing an interpersonal relationship such that the client can experience emotional arousal and then return to their set point more quickly, and perhaps slowing the rate at which they become more aroused throughout the session. It is possible that clients who have such an experience in psychotherapy are more likely to improve. Testing this hypothesis may involve combining physiological data with self-report measures of emotional experience and distress, and therapeutic outcomes, and relating such measures to coregulation.

Some theories suggest that therapists could serve their clients by aiding emotion regulation, while others suggest it may impede a client from developing independent emotion regulation skills. For example, it is possible that a therapist's coregulatory function in psychotherapy could be iatrogenic for specific treatment goals. For example, the goal of some cognitive and behavioral treatments is to teach clients skills they can use to regulate their emotions on their own. If a client implicitly relies on the therapist to help them manage their emotions in sessions, this process may serve an avoidance function whereby clients learn that they cannot manage distressing feelings on their own (Hofmann, 2014). There may be utility in working through difficult emotions, becoming more emotionally aroused during therapy, and not being immediately regulated by one's therapist. Yet, at the same time, it may be difficult to learn new skills if the client is too emotionally activated and not changing these emotional states in session (e.g., Pascal-Leone & Greenberg, 2007). For example, Prolonged Exposure (e.g., Foa, 2011) requires clients to discuss traumatic events, which may cue large emotional

reactions, thus potentially blocking them from developing new emotion regulation skills. The client may rely more heavily on the therapist to feel grounded and safe during session.

In addition, we do not know what specific interventions the therapist used that may have impacted the system of regulation enacted over the course of the session. As the current study included Motivational Interviewing sessions, the therapist may have been verbalizing the felt experience of the client's narrative through reflections or questions, which could help the client feel less distressed throughout the session. Alternatively, certain types of confrontation may result in a client rapidly increasing their arousal. Further research is necessary to investigate if these specific MI interventions facilitate various degrees of emotion coregulation or if simple changes in emotional arousal by the therapist were directly responsible for client changes in emotion.

Further, the interaction of body language (Ramseyer & Tschacher, 2011), and other physiological measures (e.g., skin conductance; see Marci et al., 2007) may provide additional sources of information. Vocal arousal may not capture all channels of arousal during a session (it cannot be measured when the client is silent). Thus, nonverbal behaviors and measures of physiological arousal might compliment vocal measure to provide a more complete assessment of emotional experience (Scherer & Ellgring, 2007). We selected vocal acoustics as the avenue of exploring emotion in the therapeutic relationship, but did not study the words in conjunction with sound. Vocal conversation data includes two pieces of data – what is said (i.e., the words) and how it is said (i.e., the sound, tone, and inflection). Words may provide further clues about how regulation is enacted during a therapy (e.g., more detailed clues about emotion valence). Further research combining multiple avenues of physiological and behavioral data may aid in a deeper understanding of how a productive therapeutic environment is created.

Finally, when interpreting individual coefficients of a dynamic system model, it is important to consider that though these coefficients may individually provide indications of psychological processes, they are a part of a larger system of effects that is challenging to interpret due to many unknown variables in higher order oscillatory patterns. One such pattern is the difference in magnitude between the intra and interpersonal effects coefficients. Though, theoretically, the interpersonal effects are of more importance, the intrapersonal effects coefficients are an order of magnitude higher. Further study may be necessary to understand these differences. However, while the interpersonal coefficients are smaller, they are significant predictors of emotional expression. Additionally, due to the theoretical framework of dynamic systems modeling, it may not be necessarily appropriate to calculate effect sizes or interactions. Dynamic systems models have very specific meanings, which are not congruent with standard APIM models, and introduce deeper complexity to those statistical tests. For this paper, we chose to present our significant main effects, and encourage further understanding of how dynamic systems models function within psychotherapy.

This study indicates basic emotional processes are involved in the ongoing interaction of therapists and clients and that these patterns may provide an additional way to test specific hypotheses about how psychotherapy works. Broadly, the current results suggest that the

therapeutic relationship involves a process of ongoing mutual influence between therapist and clients where they both have an impact on the emotional expression of the other. Emotion coregulation is yet another interpersonal process the may contribute to understanding how and why psychotherapy is an effective mental health treatment. Clinically, the therapist should be aware of the ways in which ongoing interactions with a client during a session may have an impact on their emotional state, as well as their potential effect on the client's emotional state. Future research should identify how the therapist might utilize the process of coregulation to create a sense of safety and support, allowing the dyad may be able to work collaboratively towards therapeutic goals.

Funding and Conflicts of Interest

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Appendix A: Calculation of Derivatives

The dynamic system models tested in this study take zero, first, and second order derivatives as primary inputs. Derivatives refer to the change in a variable with respect to time (i.e., slope or rate of change). In this study, we calculated derivatives to quantify changes in therapist and client vocally encoded emotional arousal over the course of a session. Typically, dynamic systems models rely on time series data that is not regularly censored over time (e.g., heart rate and skin conductance can be measured for both members of a dyad at the same time; see Helm et al., 2012). However, conversational data is inherently imbalanced, while one person talks, the other is typically silent. This structure prevents the estimation of derivatives for each partner that overlap with one another throughout the time series.

To address this feature of the data, we smoothed f_0 observations over three therapist or client talk turns, resulting in data that is functionally overlapping. Prior to calculating the talk turns and derivatives, we person-centered f_0 for therapist and client for each session. This average served as the person's set point (i.e., their person-specific mean). If a set of three client and therapist talk turns is structured as C1, T1, C2, T2, C3, T3, we took the mean of C1-C3 and T1-T3 and treated them as occurring at the same time point $C1_m$ and $T1_m$. This cycle was repeated with the next set of three, and iterated for the remainder of the session.

Derivatives were computed using local linear approximation (LLA). The LLA was computed using three smoothed talk turn sets of f_0, ($\tau = 3$) where t represented the talk turn set being estimated and points occurring before and after a selected time (i.e., $x_{t-\tau}, \quad x_{t+\tau}$), and τ represents the number of data points utilized to compute the average.

The two equations below approximate the first (*Velocity*) and second (*Acceleration*) derivatives, respectively, where *t* represents time (Deboeck et al., 2008; Boker & Laurenceau, 2005). Emotional arousal *Level*, *x,* (i.e., the zero derivative) was the average of the three talk turn sets for a given speaker (therapist or client) and was used to calculate 1st and 2nd derivatives.

$$\frac{dx}{dt} \approx \frac{x_{t+\tau} - x_{t-\tau}}{2\tau\Delta t} \tag{2}$$

$$\frac{\mathrm{d}^2x}{dt^2} \approx \frac{x_{t+\tau} + x_{t-\tau} - 2\mathrm{x_t}}{\tau^2\Delta t^2} \tag{3}$$

The 1st derivative (2) is represented as $\frac{dx}{dt}$, and indicates change in arousal (i.e., *Velocity*). *Velocity* was calculated by taking the slope of the line between the two sets of points (first and second, second and third). The 2nd derivative (3) is represented as $\frac{\mathrm{d}^2x}{dt^2}$, and indicates how quickly the individual returned to their set point (i.e., *Acceleration*). *Acceleration* describes the change in *Velocity*; that is, how the rate of change in emotional arousal is speeding up or slowing down and was calculated by subtracting the slope values (Deboeck et al., 2008).

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Clinical Impact and Methodological Statement

The implications of this study are to 1) more deeply understand psychotherapy processes using more technical methodologies, and more specifically to 2) demonstrate and examine the process of the bi-directional emotional linkage that occurs between clients and therapists.

First, advancements in data science allow us to understand psychotherapy process with granularity. Vocal acoustics have provided a less invasive methodology for investigating psychotherapy process. Additionally, dynamic systems provide both an innovative and growing quantitative methodology, within the psychotherapy process literature, as a means of exploring the complex process of emotion coregulation. Second, we established that the process of coregulation is occurring within these therapy sessions, as well as differentiating and hypothesizing as to how and why coregulation is different for therapists and clients. By conducting this study, we aimed to better understand how and why psychotherapy is an effective mental health treatment.

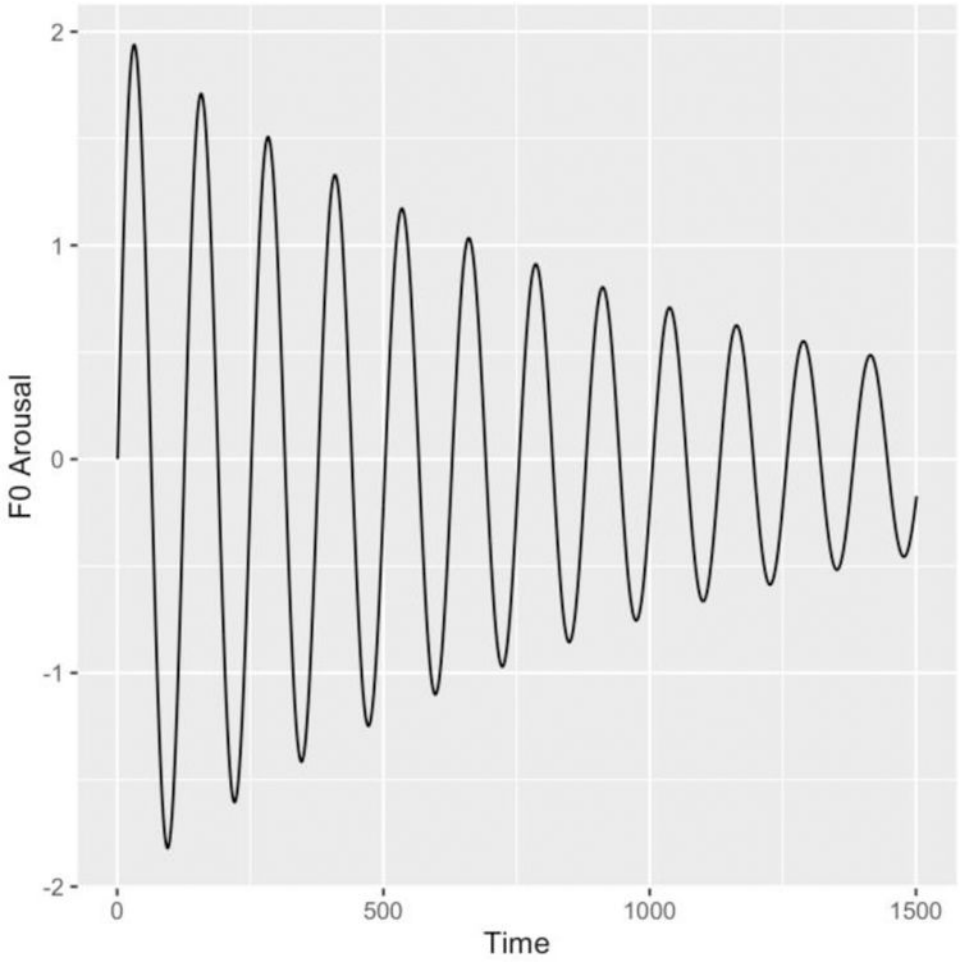

Figure 1a.
Higher Levels of Arousal Decreasing to Lower Levels of Arousal

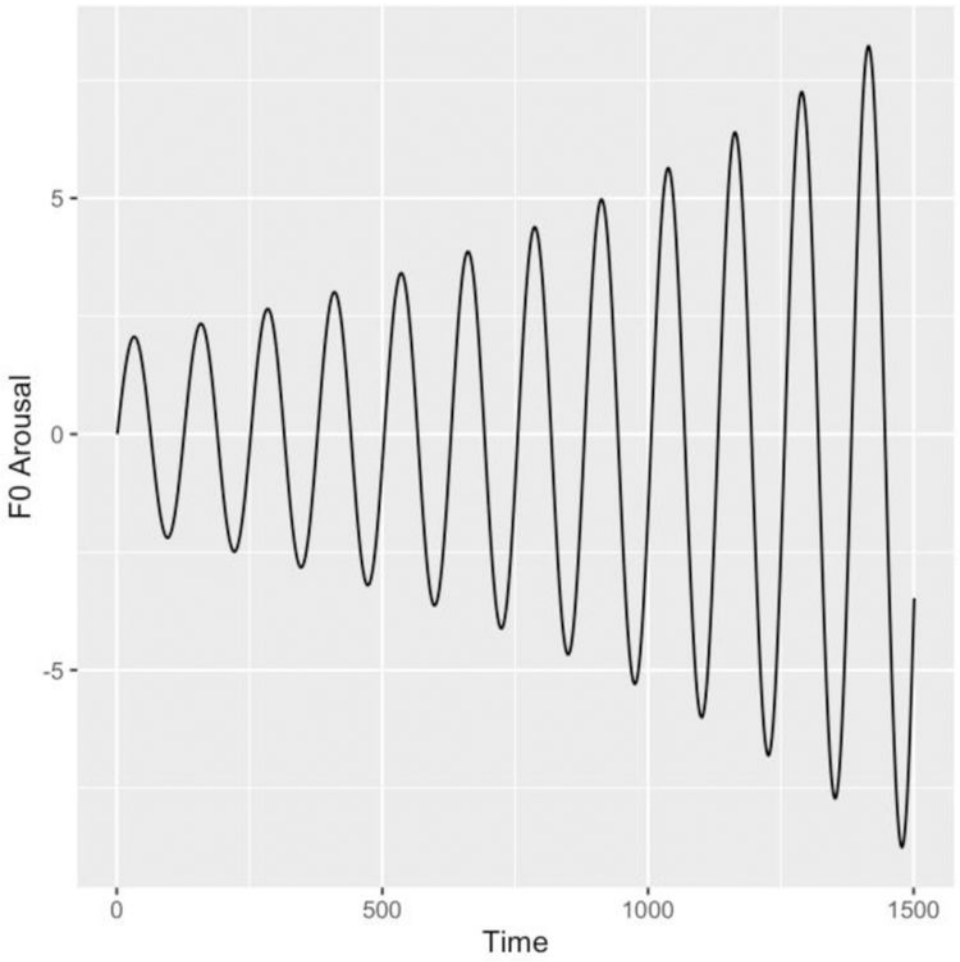

Figure 1b.
Lower Levels of Arousal Increasing to Higher Levels of Arousal