نظریه وارونه‌سازی و ارتباط متقابل فیزیولوژیک در تعاملات دوتایی مادران و دختران کم تعارض و پر تعارض*

Reversal theory and physiological linkage in the low-conflict and high-conflict mother-daughter dyadic interactions

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چکیده

این آزمایش ارتباط متقابل فیزیولوژیکی را در زوجهای مادر ـ دختر با استفاده از سازه‌های نظریه وارونه‌سازی (Apter, 1982) شامل حالت‌های فرا انگیزشی، و فرآیندهای وارونه‌سازی مورد بررسی قرار داده است. ارتباط متقابل فیزیولوژیکی مقیاسی از کیفیت و میزان پیش‌بینی پاسخ‌های فیزیولوژیکی یک فرد از الگوهای پاسخ فیزیولوژیکی فرد دیگر است. از بین ۶۳ زوج مادر ـ دختر که در یک آزمایش قبلی (غفار تبریزی، ۲۰۰۳) شرکت کرده بودند، یک گروه پر تعارض (۱۲ زوج) و یک گروه کم تعارض (۱۲ زوج) بر اساس خرده مقیاس تعارض از مقیاس محیط خانواده (Moss&moss 1994) تشکیل شد. این مطالعه سطح ارتباط متقابل فیزیولوژیکی بین زوج‌ها و همچنین پیش‌بینی کننده‌های هیجانی و فرا انگیزشی ارتباط متقابل فیزیولوژیکی را در تعاملات خنثی، متعارض و مطبوع مطالعه نمود. نتایج نشان داد که پاسخ‌های فیزیولوژیکی دختران پاسخ‌های مادران را بهتر پیش‌بینی کرد تا بر عکس این مورد. طبق نتایج، میزان عناد طلبی و آرامش دختران پیش‌بینی کننده ارتباط متقابل بود. سود و زیان تعاملی نیز با فیزیولوژی مشترک ارتباط داشتند. برای گروه پر تعارض، ارتباط متقابل فیزیولوژیکی در زمان مکالمه متعارض قوی‌تر از زمان مکالمه مطبوع بود. به‌طور کلی، داده‌ها سودمندی سازه‌های نظریه وارونه‌سازی را در توضیح تداخل اثر بین فرآیندهای فرا انگیزشی، هیجانی حین تعاملات و ارتباط متقابل فیزیولوژیکی بین زوج‌های مادر ـ دختر نشان داد. با این وجود، عوامل شناختی، کلامی و غیر کلامی که ارتباط متقابل فیزیولوژیک را بر می‌انگیزند، باید هدف مطالعات آینده قرار گیرند.

واژه‌های کلیدی: نظریه وارونه‌سازی، ارتباط متقابل فیزیولوژیک، حالت‌های فرا انگیزشی، فرآیندهای وارونه‌سازی، هیجان‌های جسمی و تعاملی

Abstract

This experiment investigated the physiological linkage in mother-adolescent daughter dyads using reversal theory constructs including metamotivational states, and reversal processes. Physiological linkage is a measure of how well the physiological responses of each member of each dyad predict the other member's response pattern. Among 63 mother-daughter dyads participating in an earlier experiment a high-conflict group (12 dyads) and a low-conflict group (12 dyads), were established on the basis of the Conflict subscale of Family Environment Scale. The study examined the levels of physiological linkage between dyads and identified the metamotivational and emotional predictors of physiological linkage during the neutral, conflictual and pleasant interactions. The results indicate that the physiological responses of daughters predicted the responses of mothers better than vice versa. It was shown that daughters' ratings of provocativeness and placidity were both predictive of linkage. Both transactional loss and gain were related to shared physiology. For the high-conflict group, physiological linkage was stronger during the conflictual conversation than the pleasant conversation. On the whole, the results demonstrated the utility of reversal theory constructs in explaining the interplay between the metamotivational and emotional processes during interactions and physiological linkage between mother-daughter dyads. However the verbal, non-verbal, and cognitive factors that instigate physiological linkage remain to be investigated.

Keywords: Reversal Theory, physiological Linkage, metamotivational states, reversal processes, somatic and transactional emotions.

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Introduction

Physiological Linkage in Mother-Daughter Dyads

The studies on physiological linkage in families started with Levenson and Gottman's work on married couples (1983). The researcher's appling bivariate time-series analyzed data regarding heart rate, skin conductance, pulse transmission time, and somatic activity from both spouses in order to derive a measure of physiological linkage. Self-report affective data (obtained by a dial rating of positive/neutral/negative affect during a video-recall procedure) were analysed using sequential analyses to derive a measure of affect reciprocity. The authors reported that the physiological linkage and the observed emotional expression for married couples was greater during the discussion of high-conflict issues than during low-conflict discussion on an event of the day. They also found that physiological co variation during discussion of the high-conflict issue accounted for over 59% of the variance in marital satisfaction. Although the self-rating of affect increased the variance accounted for by 16%, the affective measures were not correlated with the physiological measures. Faced with this striking data, Levenson & Gottman (1983) concluded that "Physiological linkage reflects the ebb and flow of the negative affect, the escalation and de-escalation of conflict, and the sense of being locked into the interaction and unable to step back that can occur when spouses in dissatisfied marriages attempt to solve problems and when this kind of patterned conflict occurs in other dyadic interaction" (p. 596). In a follow-up study conducted 3 years later, Levenson and Gottman (1985) found that it was not physiological linkage but physiological arousal which was the predictor of decline in marital satisfaction.

In a further attempt to explore the relationship between empathy (defined as the ability to perceive accurately how another person is feeling) and physiology, Levenson and Ruef (1992) found that accuracy of rating the negative emotion (i.e., the observer's ratings of the target spouse's emotion) was greater when observer and target evidenced high levels of physiological linkage whereas the accuracy of detecting positive emotion was related to a state of low arousal in the observer, but not to physiological linkage between observer and target. O'Mara (2001)'s similar work on non-distressed couples corroborated the Levenson and Ruef's (1992) interpretation that physiological linkage signifies the feeling component of empathy. O'Mara found that physiological linkage accounted for 51% of variation in marital satisfaction. Further, it represented more than simply the exchange of negative affect in the relationship, but also represented empathy in neutral and positive affective exchange. Wagner and Calam (1988) used the methodology applied by Levenson and Gottman (1988) in their pilot study on six volunteer parent-child dyads. Despite the small sample size, the experiment yielded compelling results. The experimenters found that, for four dyads, the physiological responses of the parent were predictable from the child's responses.

The data of previous research on the shared physiology in married couples provides strong support for the relationship between marital satisfaction, empathy and physiological linkage. However, these studies offer different interpretations of physiological linkage (although these interpretations are not mutually exclusive) as either an indicator of negative affect during the conflictual conversation for the distressed couples or an index of a high level of empathic listening in the overall interaction of non-distressed couples. The lack of agreement in these interpretations is partly caused by the lack of measures of affect

which could identify different aspects of emotional experience during dyadic interaction that is listening and conversing. The measures were limited to perspective taking and marital satisfaction (Omara, 2001), overall hedonic tone and dial rating. (Levenson & Gottman, 1983) A thorough knowledge of the emotional experience of the individual during physiological linkage could elucidate the nature of the affective message(s) sent and received by members of a dyad. In this way, the physiological linkage is interpreted in the light of the subjective experience of both the sender and the receiver of an emotional message. Such an exploration requires a phenomenological approach which starts from the subjective experience of the individual and then moves towards the physiological reactions. Moreover, the extent to which a person reacts emotionally and physiologically to the responses of the other party is determined by his/her current metamotivational state (Apter, 1983). Everyone could compare different occasions during which, he/she reacted differently to the similar emotional and physiological responses of a relative or friend. For instance, a wife might express higher levels of emotional and physiological responses towards her husband's disclosure of a workplace adversity if she is in state of mind that render her caring and empathic rather than self-centered and preoccupied with her own problems at home. Reversal theory (Apter, 1983) as a phenomenological and structural approach could overcome the above-mentioned methodological and theoretical flaws.

Reversal theory proposes that there are a number of metamotivational states which are identifiable and discrete ways of experiencing the world, and are each associated with their own range of emotions (Apter, 1989). The reversal theory proposes two pairs of somatic (i.e., telic-paratelic, conformistic-negativistic) and two pairs of transactional metamotivational states (i.e., autic-alloic and mastery-sympathy). The telic state is characterized as an arousal-avoiding, future-focused, goal-oriented and serious-minded state. People in paratelic state are sensation oriented, arousal seeking, present-focused, playful and spontaneous (Apter & Svebak, 1992; Potocky & Murgatroyd, 1993). The conformist and negativistic pairs of metamotivational states concern the extent to which one temporarily conforms with or reacts against any restrictions on one's behaviour including another person's expectations, social pressure, norms, rules, regulations and traditions. (Potocky & Murgatroyd, 1993). The combination of telic/paratelic and conformist/negativistic pairs of metamotivational states produce four state combinations: telic-conformist, telic-negativistic, paratelic-conformist, and paratelic-negativistic.

Apter (1988) presented a systematic account of pleasant and unpleasant emotions, being dependent upon the operation of particular modes of consciousness. The telic/paratelic and negativistic/ conformist states produce eight somatic emotions which are modulated by felt arousal. Low arousal in the telic-conformist state and the telic-negativistic state is associated with emotions like relaxation and placidity respectively; high arousal is experienced as anxiety and anger. Low arousal in the paratelic-conformist state and the paratelic-negativistic state produces emotions like boredom and sullenness respectively; whereas high arousal is experienced as excitement and provocativeness.

In addition to the eight somatic emotions, there are eight other emotions which are modulated by felt transactional outcome. The felt transactional outcome is the degree of gain or loss that the person experiences as a result of transactions with others (Potocky & Murgatroyd, 1993). Apter and Smith (1985) describe the mastery/sympathy and autic/alloic pairs of metamotivational states. These

two pairs jointly define the person's emotions with respect to felt outcomes of a transaction. In the mastery state, one feels a need to dominate or control the other with whom he/she is interacting, and transactions are experienced as involving taking or yielding (Murgatroyd, 1985). The person who is in a mastery-oriented state views a relationship as a power struggle and evaluates relationship outcomes in terms of winning power and control and values hardness and toughness (Frey, 1997). When people are in the sympathy state, they view the situation in terms of harmony or unity. They are focused on caring and they value tenderness and sensitivity, and transactions are experienced as giving or receiving (Potocky & Murgatroyd, 1993; Frey, 1997).

The second pair of transactional states consists of the autic and alloic states. An individual in autic state is primarily focused on his or her own outcomes, whereas, for a person in the alloic state, the outcome and happiness of the other person with whom one is interacting is the matter of primary concern (Frey, 1997). The combination of the mastery/sympathy and autic/alloic pair of states produces four transactional combinations: autic-mastery, alloic-mastery, autic-sympathy and alloic-sympathy. In the mastery/autic state, gain is associated with the emotion of pride and loss with humiliation; in the mastery/alloic state, gain produces the emotion of modesty and loss leads to shame. In the sympathy/autic state, gain produces the emotion of gratitude and loss leads to resentment; whereas in the sympathy-alloic state, gain is associated with feeling of virtue and loss with guilt (O'Connell & Apter, 1993).

Reversal from one state to the other can be triggered by contingent events (internal or external stimuli), frustration, and satiation or some combinations of these factors (Apter, 1989). "*Contingent factors* are events and situations which, when situably interpreted by an individual, facilitate or induce a reversal. *Frustration* of all kinds in achieving the satisfaction of the prevailing system will eventually induce reversal on its own or with the help of other factors. When a person is in a particular state for a period of time without achieving the satisfaction of that state, he/she may spontaneously reverse to the opposite state. *Satiation* is an innate process which builds up in strength, even in the absence of the other factors, and will automatically induce a reversal" (Apter & Svebak, 1992, p. 329). For instance, if a student experience telic state during a long seminar, towards the end of it, satiation (being bored and fed up with tolerating the serious-minded and goal-oriented state without experiencing fun and excitement) will instigate reversal from the telic state to the paratelic one. He/she may then leave the seminar and start a computer game in order to seek excitement.

Given the contradictory interpretations of physiological linkage in previous research (e.g., Levenson and Gottman, 1983 &1985; Levenson & Ruef, 1992; O'Mara, 2003) and lack of appropriate and complete measures of subjective emotional experience in earlier studies, it is vital to apply reversal theory, with its comprehensive measures of emotions, to the exploration of physiological linkage during dyadic interactions. To examine the generalizabilty of previous findings on married couples, it is necessary to replicate the investigation on other family dyads. Among parent-child dyads, mother-daughter dyads with the highest level of conflict (Paikoff, Carlton-Ford, & Brooks-Gunn, 1993), increased negative affect (Montemyer, Eberly, & Flannery, 1993) and cohesion (Rossi & Rossi, 1990) require further investigation. Taking into consideration that adolescence is a dynamic developmental period during which the pursuit of independence and identity serve to intensify the duration and manifestation of negative emotions

(Roberts, 1999), examination of physiological linkage for mother-adolescent daughter dyads could shed light onto the complexity of parent-adolescent interactions. In this respect, comparison of the low-conflict and high-conflict mother-daughter dyads would add to the knowledge regarding the emotional and physiological concomitants of perceived conflict as one of the most salient indices of the parent-adolescent relationship (Graber & Brooks-Gunn, 1999; Hall, 1987; Katz, Kramer, & Gottman, 1992; Minuchin, 1985; Powers & Welsh, 1999). Overall, this study aims to investigate physiological linkage in the low-conflict and high-conflict mother-daughter dyadic interactions using reversal theory constructs.

It is hypothesized that;

1) The levels of felt arousal would be associated with the strength of physiological linkage during dyadic interaction
2) The physiological responses of the listener would follow those of the speaker
3) Physiological linkage occur and would increase from the neutral to pleasant interactions and would be highest for the conflictual interaction
4) The high-conflict dyads would exhibit higher levels of the physiological linkage than the low-conflict dyads

Method

Participants

Among 63 mother-daughter dyads participating in an earlier experiment (Ghafar-Tabrizi, 2003) a high-conflict group (12 dyads) and a low-conflict group (12 dyads), were established on the basis of the Conflict subscale of Family Environment Scale (Moos & Moos, 1994). Mothers' age ranged from 32.9 to 55.7 (M = 43.4, SD= 6.1) and daughters' age ranged from 13.9 to 17.5 (M = 15.1, SD= 0.9).

Measures

Physiological measures. Four psychophysiolo-gical responses (Finger Pulse Amplitude (FPA), Heart Rate (HR), Skin Conductance Level (SCL) were recorded from each mother and daughter participant simultaneously using a Power Macintosh 7300/180 computer linked to a MacLab/8E data acquisition system using Chart version 3.5.6 software. Recordings were made with a sampling frequency of 200/s. SCL was not scored and analyzed because, for a number of dyads, SCL data moved out of the range of the measuring equipment (i.e., plus or minus10 μS from the initial baseline setting). This problem led to the loss of SCL data for these dyads. Therefore, the SCL data was not included in this experiment.

The Family Environment Scale (FES) (Moos & Moos, 1994). The FES is one of the ten Social Climate Scales. The FES is composed of 10 subscales that measures the actual, preferred and expected social environment of families. These 10 FES subscales includes Cohesion, Expressiveness, Conflict, Independence; Achievement Orientation, Intellectual-Cultural Orientation, Active-recreational Orientation, Moral-Religious Emphasis, Organization and Control subscales. The raw score of 0 indicates the absence of that characteristic in the family measured by each subscale, and a score of 9 demonstrates a high level of that characteristic in the family. Each dyad's score is calculated by averaging the scores of mother and daughter in that dyad.

Moos's (1994) findings drawn from a sample of 1067 family indicates that a 2-month test-retest reliability for Form R (actual family environment) varies from a low of .68 for independence to a high of .86 for cohesion. Test-retest reliability were also high for the 4-month interval. The internal consistency for the 10 FES subscales were all in an acceptable range and varies from moderate for

independence and achievement orientation to substantial for cohesion, organization, intellectual-cultural orientation and moral-religious emphasis (Moos, R, & Moos B., 1994). "Validity analyses with the Family Routines Inventory and the Spanier Dyadic Adjustment Scale have yielded strong correlations attesting to FES's validity" (Ross, Marrinan, Schattner & Gullone, 1999, p. 60).

The Telic State Measure (TSM) (Svebak & Murgatroyd, 1985). In this study, the TSM was completed by participants before and after each conversation task. TSM was used to examine the extent to which the telic/paratelic state of participants changed as a result of being engaged in different conversations. This measure consists of four six-point scales with descriptors at each end (playful-serious, preferred spontaneous-preferred planning ahead, felt low arousal-felt high arousal and preferred high arousal-preferred low arousal) (Svebak & Murgatroyd, 1985). The latest version of this measure (i.e., the 12-item telic/paratelic state instrument or T/PSI) was shown to be unidimensional and to have excellent internal consistency reliability, Cronbach's alpha=0.89 (O'Connell, & Calhoun, 2001)

The Tension and Effort Stress Inventory (TESI)-State Version (Svebak, 1991).

The state TESI has 20 response items, each rated on a scale of 1–7 ranging from 'not at all' to 'very much'. There are 16 items measuring the reversal theory emotions and four stress items measuring external and somatic tension stress and external and somatic effort stress. Because the TESI has only one item for each emotion or stressor, Cronbach alpha coefficients cannot be derived for individual measures; however, the emotion ratings have either positive or negative hedonic tone in common. Male and Kerr (1996 in Kerr, Wilson, Svebak & Kirkealdy, 2005) reported an alpha coefficient of 0.88 for the eight positive emotions and an alpha coefficient of 0.75 for the eight negative emotions.

The Visual Analogue Scales (VAS) (McCormack, Horne, & Sheather, 1988).

Visual Analogue scales have been used widely and effectively in psychological medicine as a clinical and research tool in order to measure the subjective experience and behaviour of the participants (McCormack, et al., 1988). According to Aitken (1969 in McCormack, et al., 1988) VAS are suited to both within-subject repeated measurement and between-group studies. Previous investigations have generally reported high level of validity and inter-rate reliability of VAS (McCormack, et al., 1988). The VAS have been used widely and effectively to measure subjective experience and behaviour of the participants (McCormack et al., 1988), and they are suited to both within-subject repeated measurement and between-group studies (Aitken, 1969). VAS typically consist of a ten centimetre line anchored at both ends with words descriptive of maximal and minimal extremes of the dimension being measured. In this study, the VAS were used to measure the participants' experience of stress (comfortable or calm-worried), arousal (sleepy-active) (King, Stanley, & Burrows, 1987) and hedonic tone (unpleasant-pleasant) before and after each conversation.

Procedure

Each mother-daughter dyad sat in a comfortable upright chairs in a room at a distance of 1.5 m facing each other. The participants were given a full explanation of the purpose of the study and asked to sign a consent form. Then, the electrodes for the physiological measures were attached to the participants, and measurement devices were tested. Mothers and daughters were asked to take turns at discussing a neutral, a conflictual and a pleasant topic while continuous physiological readings were

taken. For each conversation topic, there were a 4-minute baseline and two 8-minute conversation segments (mother lead the conversation, daughter lead the conversation), namely, 20 minutes was required for each conversation topic (a total of 60 minutes for the three topics). At the outset of the experiment, necessary instructions regarding the TESI, TSM and VAS were given. From an adjacent room, the experimenter monitored the conversations via an intercom and gave a signal to each dyad to start or stop a segment. During the baseline period, the dyads were asked to be silent and relaxed and to think of a neutral topic like making a drink of coffee. During the conversation turns, each participant was asked to listen quietly when the other person was talking. They were free to ask occasional questions for clarification but were instructed not to argue. This rule aimed to control for the effect of a dominant speaker on the predictability of physiological linkage. The order of conversation topics and mother/daughter's conversation turn were counter balanced across dyads. After each baseline and conversation turn TESI, VAS and TSM were completed. Therefore, each participant completed each of these measures nine times throughout the experiment. The physiological recordings were stopped while the participants were completing these measures.

Design

The strength of physiological linkage. A mixed (within-subject and between-group) repeated measures design was used to examine the three last hypotheses. Within-subject factors were, lead (baseline, mother lead and daughter lead), predict (mother predict and daughter predict) and topic (neutral, conflictual and pleasant). It is necessary to explain that Lead describes the experimental condition but predict indicates the direction of the predicability of physiological linkage derived via the bivariate time-series analysis. For each of the physiological measures (i.e., HR and FPA), the only dependent variable was the strength of physiological linkage, that is the linkage score (*z*-score) regardless of its statistical significance and direction (mother/daughter predict).

The Williams and Gottman (1982) time-series analysis program provided *z*-score outputs for each analysis of paired data for each mother-daughter dyad. The values of *z*-scores equal to or above 1.96 indicate that significant physiological linkage exists at the .05 level of significance. The strength of physiological linkage includes all bivariate physiological linkage scores whether they were significantly related or not.

Predictors of physiological linkage. The last part of this experiment involved a correlational study examining the predictor variables of the strength of physiological linkage (the criterion variables) among different measures of metamotivational states and emotions and testing the hypothesis that the levels of felt arousal would be associated with the strength of physiological linkage (hypothesis 1). The criterion variables comprised the strength of physiological linkage for HR and FPA, an overall index (combining HR and FPA) and seven indices of physiological linkage during mother lead, daughter lead, mother predict and daughter predict and for each conversation topic.

Data analysis

Strength of physiological linkage. Descriptive statistics were used to calculate the percentage scores of significant mother predict and daughter predict physiological linkage in each segment of each conversation topic. For each of the two physiological responses, the strength of physiological linkage during turn-taking conversations were analyzed using a 2 (Conflict: Low-conflict/High-conflict) x 3 (Topic: Neutral,

Conflictual, Pleasant), x 2 (Lead: Mother/Daughter) x 2 (Predict: Mother/Daughter) repeated measures ANOVAs. ANOVAs with Greenhouse-Geisser corrections for repeated measures, were employed to assess the change in dependent variable across all of the independent variables. The dependent variable was the strength of physiological linkage, that is all the *z*-scores irrespective of their direction (mother/daughter predict) and whether they were significantly related or not. ANOVA and t-tests were performed to identify the source of significant main effects or interactions as appropriate.

Predictors of the strength of physiological linkage. To examine the predictors of the strength of physiological linkage during mother-daughter dyadic interaction, separate series of stepwise multiple regression analyses were performed for mothers and daughters. It was necessary to perform a number of separate analyses on smaller numbers (subsets) of variables in order to achieve an acceptable ratio of variables to subjects (Tabachnick & Fidell, 1989). The analyses aimed to explore the contribution of metamotivational states, arousal, stress, hedonic tone and emotions to the strength of physiological linkage during dyadic interaction. For these analyses, a number of criterion variables were used. There were 10 criterion variables. Two separate indices of the strength of physiological linkage for HR and FPA were obtained by collapsing all bivariate scores across different lead (mother lead/daughter lead) and predict (mother predict/daughter predict) segments and conversation topics. There were three separate indices of physiological linkage for each conversation topic. An overall index was obtained by collapsing the data for HR and FPA. Also, the bivariate scores for physiological linkage for HR and FPA for the three conversation topics were combined to yield four indices of physiological linkage for mother predict (the physiological pattern of mother predicts the response pattern of daughter), daughter predict, mother leads the conversation and daughter leads the conversation.

For each of the 10 criterion variables, seven groupings of predictor variables were examined for mothers and daughters respectively. The predictor variables were VAS scores (analysis 1); TSM scores (analysis 2); TESI ratings of stress for external factors, body stress, effort for external factors and effort for body stress (analysis 3); TESI ratings of relaxation, anxiety, boredom and excitement (analysis 4), TESI ratings of placidity, anger, provocativeness and sullenness (analysis 5); TESI ratings of pride, humiliation, modesty and shame (analysis 6); and TESI ratings of gratitude, resentment, virtue and guilt (analysis 7). For the purpose of clarity, it should be noted that although there were no linkage scores for baseline period (physiological data during baseline was used to obtain normalized data for conversation segments), after each baseline, there were emotional ratings which were used in obtaining some of the predictor variables. Due to the sensitivity of multiple regression analysis to outliers, *z*-scores three standard deviations beyond the mean scores were replaced by the mean scores (see Tabachnick & Fidell, 1989). There were a total of 7 outliers.

Results

Among all the bivariate *z*-scores, 32% indicate significant physiological linkage (16% for each of the lead segments; 17% for FPA and 15% for HR; 19% for daughter predict linkage and 13% for mother predict linkage; 16% for the low-conflict group and 16% for the high-conflict group). The breakdown across the neutral, conflictual and pleasant conversations was 29%, 36% and 31% respectively.

To examine the strength of physiological linkage, all the *z*-scores of bivariate time-series analyses

were used irrespective of whether they were significant or not. The list of significant main effects and interactions for the ANOVAs on these *z*-scores are displayed in Table 1. From Table 1, it can be seen that the ANOVA on the strength of physiological linkage of HR yielded a main effect for predict but not for lead, topic or conflict. The HR of daughters (M = 1.53, SD = 0.67) predicted the HR of mothers significantly better than vice versa (M= 1.04, SD = 0.49). The strongest physiological linkage during the conflictual conversation was a non-significant trend, F (1.85, 40.69) = 3.14, p= .068. There were significant interactions for lead x predict, lead x predict x topic, and lead x predict x conflict.

The ANOVAs on HR and FPA did not support the hypothesis (4) that the physiological linkage would be greater for the high-conflict group than the low-conflict group. However, for the ANOVA on FPA linkage, the topic x conflict yielded significant differences which were exclusive to the high-conflict group. For this group, the physiological linkage was stronger during the conflicutal conversation than the pleasant conversation. The lead x predict interaction for the ANOVA on the strength of physiological linkage for HR provided partial support for the hypothesis (2) that the physiology of the listener would follow that of the speaker. When daughters led the conversation, their HR predicted the response pattern of mothers significantly better than vice versa. Also, when mothers led the conversation their HR predicted their daughters' response pattern significantly better than when daughters led the conversation. Also, the lead x predict x conflict interaction showed that, only for the high-conflict group, when daughters led the conversation, the HR of daughters predicted the HR of mothers significantly better than when mothers led the conversation. The ANOVA on FPA did not confirm the second hypothesis regarding the impact of listening on the direction of physiological linkage during mother-daughter interaction. The ANOVAs on physiological linkage for HR and FPA did not support the hypothesis (3) that the physiological linkage occur and would increase from the neutral to pleasant interactions and be highest for the conflictual interaction. For the ANOVA on HR linkage, the main effect for predict revealed that physiological linkage was stronger when the HR of daughters predicted the response pattern of mothers than vice versa. Furthermore during the pleasant conversation, the HR of daughters predicted the HR of mothers significantly better than vice versa.). For HR., the lead x predict interaction revealed that, when daughters led the pleasant conversation, the HR of daughters predicted the HR of mothers significantly better than vice versa. Also, when mothers led the pleasant conversation, their HR predicted the HR of daughters significantly better than when daughters led the conversation.

Table 48. The List of Significant Main Effects and Interactions for the ANOVAs on the Strength of Physiological Linkage for HR and FPA (N = 24 dyads)

Physiological Measures	Significant Main Effects and Interactions	*F*	df	*p*
HR	**Predict**	7.61	1, 22	.011
	Lead x Predict	4.63	1, 22	.043
	Lead x Predict x Topic	3.45	1.94, 42.47	.042
	Lead x Predict x Conflict	6.43	1, 22	.019
FPA	**Topic x Conflict**	4.19	1.66, 36.48	.029

Note. Degrees of freedom are based on the Greenhouse-Geisser corrections for repeated measures.

Table 2. Summary of the Stepwise Multiple Regression Analyses Listing the Predictor Variables of the Strength of Physiological Linkage for HR and FPA; during each Conversation Topic; and Daughter Predict, Mother Predict, Mother Lead and Daughter Lead Segments (N = 24 dyads)

Criterion Variables	Predictor Variables	*Beta*	*R^2 Change*	*F Change*	*df*	*Sig F Change*
1. HR Index	**Daughters' Felt Arousal**	0.44	0.15	4.63	1, 21	.043
	Daughters' Preferred Arousal	-0.62	0.18	4.69	1, 22	.042
	Mothers' Sullenness	0.49	0.24	6.91	1, 22	.015
	Daughters' Humiliation	-0.41	0.17	4.52	1, 22	.045
	Mothers' Virtue	0.47	0.22	6.12	1, 22	.022
2. FPA Index	**Daughters' Preferred Arousal**	0.54	0.29	8.99	1, 22	.007
3. Topic Index	**Nil**					
4. Conflictual Topic Index	**Daughters' Effort: External factors**	0.44	0.20	5.35	1, 22	.031
	Mothers' Gratitude	0.46	0.21	5.81	1, 22	.025
5. Pleasant Topic Index	**Daughters' Total Telic Score**	-0.43	0.18	4.94	1, 22	.037
6. Overall Index	**Nil**					
7. Mother Predict Index	**Nil**					
8. Daughter Predict Index	**Daughters' Placidity**	-0.53	0.28	8.47	1,22	.008
9. Mother Lead Index	**Daughters' Pride**	-0.46	0.21	5.98	1,22	.023
	Daughters' Virtue	-0.41	0.17	4.43	1, 22	.047
10. Daughter Lead Index	**Daughters' Arousal**	0.41	0.17	4.48	1, 22	.046
	Daughters' Felt Arousal	0.42	0.18	4.74	1, 22	.041
	Daughters' Provocativeness	0.45	0.20	5.63	1, 22	.027

The post hoc analyses for the lead x predict x conflict interaction showed that, when for the high-conflict group, when daughters led the conversation, the HR of daughters predicted the HR of mothers significantly better than when mothers led the conversation. For FPA, The ANOVA on the strength of physiological linkage for FPA did not yield any main effects. The post hoc analyses showed that, for the high-conflict group, physiological linkage was significantly greater for the conflictual conversation than the pleasant conversation.

Predictors of the Strength of Physiological Linkage

The results of stepwise multiple regression analyses provided partial support for the prediction that the levels of felt arousal would be associated with the strength of physiological linkage during mother-daughter dyadic interaction. The levels of felt arousal of daughters were associated with the strength of physiological linkage for HR. Also, the levels of preferred arousal of daughters were associated with the strength of physiological linkage for both HR and FPA. The index of HR linkage and other indices of physiological linkage (averages of FPA and HR linkage) for each topic and for each lead or predict segments yielded some significant predictors among different measures of tension/effort stress from body and external factors, the telic state, and the somatic and transaction emotions. A greater number of significant predictors emerged from the daughters' ratings than from those of mothers (Table 2).

Discussion

Hypotheses1: The Physiological Linkage would be Associated with the Levels of Felt Arousal.

The results of multiple regression analyses regarding the predictors of the strength of physiological linkage partially supported this prediction. However, the results across the two physiological measures were not consistent.

For FPA, higher preferred arousal of daughters was associated with stronger physiological linkage between mothers and daughters. As higher levels of preferred arousal indicates the paratelic metamotivational state, it is the daughters' paratelic state which predicts the strength of physiological linkage for FPA.

For HR, stronger physiological linkage was associated with lower level of preferred arousal of daughters and higher levels of daughters' felt arousal and humiliation, and with mothers' sullenness and virtue. The positive association between daughters' felt arousal and the strength of physiological linkage for HR shows that when daughters felt low arousal, the mother and daughter were more physiologically disengaged. While the predictive direction of lower preferred arousal of daughters for stronger physiological linkage for HR appears to be opposite to the findings on FPA; this apparent contradiction most likely reflects the different directions of the arousal responses: high physiological arousal is indexed by HR increases and by FPA vasoconstriction or decreases (Brownley et al., 2000). The findings regarding the predictors of the strength of physiological linkage between mothers and daughters has several implications. First, the predictors of physiological linkage of each physiological measure are the emotional and metamotivational correlates of physiologi-cal arousal for that measure. Second, low hedonic tone in the telic state (lower placidity) and high hedonic tone in the paratelic state (higher provocativeness) for daughters are related to stronger physiological linkage. Third, physiological linkage is positively associated with mothers' transactional emotions but negatively associated with daughters' transact-tionnal emotions.

Hypothesis 2: The Physiology of the Listener would Follow the Story Speaker

Although the findings for FPA regarding the strength of physiological linkage did not support the hypothesis, for HR, the post hoc analyses for lead x predict interaction confirmed the predicted directions. When daughters led the conversations, their HR predicted the HR of mothers more strongly than vice versa. Also, when mothers led the conversation, their HR predicted the HR of daughters more strongly than when daughters led the conversations. These outcomes are consistent with O'Mara's (2001) finding that the physiology of the person leading the conversation predicted the physiology of the person listening. However, there was an unexpected outcome. The main effect for predict indicates that the HR of daughters predicted the HR of mothers more strongly than vice versa. This outcome is consistent with Wagner and Calam's (1988) results of their pilot study on parent-child dyads.

Hypothesis 3: The Physiological Linkage would Occur and Increase from the Neutral to the Pleasant Conversation and be the Highest for the Conflictual Conversation

The results of the ANOVAs regarding the impact of conversation topic on the strength of physiological linkage on HR and FPA did not support the hypothesis. The lack of significant differences in the strength of physiological linkage across the three conversation topics is consistent with the finding of previous studies (Levenson & Gottman, 1983; Wagner and Calam, 1988; O'Mara, 2001) regarding the equivalent level of

physiological linkage across different types of conversation topics.

Hypothesis 4: The Physiological Linkage would be Greater for the High-conflict Group than the Low-conflict Group

The ANOVAs on the strength of physiological linkage for each of the physiological measures did not confirm the hypothesis. However, the topic x conflict interaction for the ANOVA on FPA produced an unexpected outcome. For the high-conflict group, physiological linkage for FPA was significantly stronger during the conflictual conversation than the pleasant conversation. This outcome supports the Levenson and Gottman's (1983) finding that physiological linkage during a conflictual segment was predictive of 59% of marital satisfaction for distressed couples. The finding suggests that the high-conflict mother-daughter dyads are more likely to follow the physiological pattern of each other during the conflictual conversation than the pleasant conversation. This interpreta-tion contrasts with a non-significant trend that, for the low-conflict group, physiological linkage was stronger during the pleasant conversation than the conflictual conversation.

Conclusion

Overall, this experiment demonstrated the value of reversal theory constructs and methodology in advancing the knowledge of physiological linkage during dyadic interaction. The use of reversal theory constructs and measures of emotions as predictors of the physiological linkage revealed the importance of metamotivational states as the predictors of the strength and direction of physiological linkage between members of dyads. The findings also reflect the importance of the conflictual interaction for the stronger physiological linkage in high-conflict dyads. In other words, the history of mother-adolescent daughter relation-ship may determine the context within which the physiological linkage is more likely to occur. During family therapy, the experiment's findings could be applied to evaluate the changes in the nature and intensity of interactions. Taking into account that this study mainly concentrated on the conflictual aspect of mother-daughter relationships, exploration of physiological linkage in the low-cohesive and high-cohesive mother-adolescent daughter dyadic interactions lies ahead.

It should be noted that the sample size and its composition indicate the need for caution in generalizing the findings to other populations. Replication of the study on larger and more varied samples would be useful to increase the statistical power and reliability of the findings. Future research, including the use of other family dyads could complement the current knowledge in the area of shared physiology for dyads. Furthermore, the verbal, non-verbal, and cognitive factors that instigate physiological linkage remain to be investigated.

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