

Transmission of Depressive Symptoms

A Study With Couples Undergoing Assisted-Reproduction Treatment

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Abstract. Transmission of depressive symptoms among spouses is well documented. In accordance with the transactional stress model, cognitive appraisals were tested as indirect effects in transmission. In 82 couples (age range women: 23–44, men: 26–55), both partners' stress appraisals and depressive symptoms were assessed at three measurement points throughout assisted-reproduction treatment. Relations among partners' variables were tested using the actor-partner interdependence model. Findings indicated positive transmission effects of depressive symptoms from men to women across both measurement intervals. A positive transmission effect of stress appraisals from men to women was observed from before until after the pregnancy test. Women's stress appraisals mediated part of the transmission of depressive symptoms from men to women. Men's stress appraisals, however, were unrelated to women's earlier depressive symptoms. Men's earlier depressive symptoms might have operated as cues for women's adjustment of their own stress appraisals, which then predicted women's increased depressive symptoms. Using the transactional model as a framework for the study of emotional transmission may help to gain a better understanding of its underlying mechanisms and possible gender or role effects involved.

Keywords: emotional transmission, couples, stress, assisted reproduction, fertility

To gain a better understanding of the possible health-protective effects of living in close relationships, many researchers have investigated dyadic forms of stress and coping in couples (e.g., Bodenmann, 1997; DeLongis & O'Brien, 1990; Luszczynska, Boehmer, Knoll, Schulz, & Schwarzer, 2007). Often, authors embed dyadic stress in the classic transactional framework on stress and coping proposed by Lazarus and Folkman (e.g., 1987).

In Lazarus and Folkman's transactional stress model, individuals' appraisals are key variables in the determination of the onset and course of the stress process. Lazarus and Folkman make a distinction between primary (demand/stakes) and secondary (resource) appraisals. Primary appraisals refer to the individual's view on the stakes of the present situation. Secondary appraisals involve subjective ratings of one's own personal resources to cope with a situation. According to the transactional stress model, the weighing and combination of these two classes of appraisals determine whether or not the person is about to "enter" the stress process. Through these two simultaneously occurring appraisals, a person may characterize an episode as either not involving stress at all or as involving challenge, threat, or harm/loss.

Harm-loss appraisals are likely to occur in situations in

which an individual has already suffered a loss or experienced some sort of damage. *Threat appraisals* involve anticipated loss or damage that has yet to occur. *Challenge appraisals* pertain to subjective ratings of situations that involve a certain amount of effort, but hold the promise of a positive outcome. While loss and threat appraisals are postulated to trigger a range of negative emotions, such as sadness or fear, challenge appraisals are hypothesized to be associated with largely positive emotions.

In predicting the dynamics of coping with stressful encounters, the transactional model is recursive in that outcomes can influence antecedent variables. Lazarus and Folkman (1987), however, caution against the complete neglect of causality and suggest the use longitudinal research with adequate time windows to test predictive directions among variables.

Bodenmann (1997) provides an extension of Lazarus and Folkman's model to a dyadic level. Bodenmann underscores the relevance of primary and secondary individual and dyadic appraisals as antecedents of dyadic stress processes. He assumes that the development of dyadic stress through demand and resource appraisals may evolve from problems concerning both partners at the same time or from problems that originally were appraised as such by only

one member of the dyad, but then spill over to the partner. Bodenmann holds that, to arrive at dyadic coping strategies, some level of agreement between partners in the appraisal of the situation is a necessary antecedent. Also, different levels of agreement in spouses' appraisals should codetermine both partners' emotional reactions to a given situation.

From clinical research it is known that exposure to persons' depressive symptoms may cause burden and even depressive symptoms in significant others themselves (e.g., Benazon & Coyne, 2000; Coyne, 1976a; Joiner & Katz, 1999). Coyne's (1976a) interpersonal model of depression stated that the social rejection of depressed persons may result from the negative mood they induce in others. Symptoms of depression may induce annoyance in others, who then feel guilty and inhibit direct expression of anger toward the depressed person.

In another hypothesis, Coyne (1976b) offered the idea that depressed persons might engage in massive support and reassurance-seeking that accounts for much of the depressed persons' rejection by their network and also their network's increased negative affect. Joiner and colleagues have taken up this claim and intensely studied the consequences of depressed persons' reassurance seeking for their network (Joiner, Metalsky, Katz, & Beach, 1999).

Since Coyne listed the evocation of negative affect as the mediator that accounts for depression contagion in depressed people's close networks, the concept of transmission has been expanded to include negative emotions in general (e.g., Segrin & Dillard, 1992). Transmission has since been studied in various mildly depressed populations using laboratory experiments and correlational data. In a meta-analysis including 36 studies, Joiner and Katz (1999) came to the conclusion that contagion of depressive symptoms and negative mood is well-documented. They offered a number of biological and cognitive mediators that might transfer negative emotions to others or serve to intensify negative emotions in others. Among more automated mechanisms, Joiner and Katz offered operant conditioning or modeling as mediators of transmission. Also, Hatfield, Cacioppo, and Rapson's (1993) theory of emotional contagion via mimicry and subsequent feedback processes is a prominent biological model of mood transmission. As cognitive mediators, Joiner and Katz (1999) proposed that negative attributions about the ill-mooded partner may be incorporated in one's own self-concept, thereby increasing one's own depressive symptoms (Aron, Aron, Tudor, & Nelson, 1991). Joiner and Katz also offered the possibility of shared or collaborative attributions as predictors of infectious negative emotions. Shared attributions for an event are likely to influence both members of the dyad in the same way emotionally.

As Bodenmann (1997) holds, the same should be true for couples' shared dyadic appraisals of a given context. Not only should they serve as a necessary means of collaborative coping with the situation, they should also determine, in part, common emotional reactions to it. Mecha-

nisms of arriving at similar appraisals of the situation may be manifold. For instance, spouses may directly communicate their appraisals to each other and convince their partners. They might also negotiate the relevance of the context and arrive at a consensus, e.g., while deciding whether or not an investment of resources into the pursuit of a common goal is feasible or likely to be successful. More indirectly, spouses might adapt their own appraisals as a response to the observation of their partners' emotional reactions to a situation. The partners' emotional reactions would then serve as a cue for the respective other partners' appraisal of the situation and, thus, trigger emotional transmission.

To our knowledge, stress appraisals and their convergence or between-partner transmission have not yet been studied, nor have appraisals of partners within a potentially stressful situation been investigated as possible mechanisms in the transmission of negative emotions or depressive symptoms.

The Present Study

The aim of this study was to investigate the interplay between spouses' stress appraisals and depressive symptoms during a potentially stressful episode. As a context, we chose assisted-reproduction treatment (in vitro fertilization and intracytoplasmatic sperm injection). This is a context in which both members of the couple likely wish to achieve a common goal, a situation which entails a high investment of resources, phases of low controllability, and a considerable risk of failure. In addition, this "acute" context is embedded in a more chronic possible source of dyadic stress that is involuntary childlessness (Benyamini, Gozlan, & Kokia, 2004).

In vitro fertilization (IVF) and intra cytoplasmatic sperm injection (ICSI) are common forms of assisted-reproduction treatments. Both treatments involve a complex regimen with one treatment cycle spanning several weeks (e.g., Eugster & Vingerhoets, 1999). Repeated treatment cycles are usually necessary to achieve pregnancy. Mean reported achieved pregnancies range between 18% and 27% per treatment cycle, depending on treatment type, the woman's age, and other factors (German IVF Register, 2006). A treatment cycle begins with hormone therapies designed to stimulate the maturation of oocytes. Oocyte-retrieval and sperm collection follow halfway through the treatment cycle. In the fertilization phase, which may last from 2–4 days, oocytes are inseminated with prepared semen under laboratory conditions. In IVF treatments, the oocyte and semen are placed together in a tube for fertilization. In ICSI treatments, a selected single sperm is injected directly into the mature egg. When fertilization is successful, embryo transfer to the uterus follows. After a waiting phase of about 2 weeks, a first pregnancy test is performed to determine the outcome.

Couples undergoing IVF/ICSI treatment face many po-

tential stressors, including their childlessness, the complex treatment regimen, and the possibility of a negative outcome (e.g., Schmidt, 2006; Verhaak et al., 2005). Accordingly, most couples experience distress during the treatment (Eugster & Vingerhoets, 1999; Morrow, Thoreson, & Penney, 1995). This is especially true for women, most likely because of potentially intense side-effects of the hormonal treatment and women's higher infertility-related distress (e.g., Berghuis & Stanton, 2002; Morrow et al., 1995).

While emotional transmission and indirect transmission via partners' stress appraisals have not been investigated in IVF/ICSI populations, there is evidence for appraisals affecting emotional development in couples coping with infertility. Stanton (1991) found men's higher threat appraisals were related to lower well-being and women's higher threat appraisals were associated with higher distress. Studying women undergoing IVF, Lord and Robertson (2005) found infertility appraisals (including e.g., infertility's timeline and consequences) to be connected with anxiety and depression. Similarly, Mindes, Ingram, Kliever, and James (2003), examining women with fertility problems, found threat appraisals were positively related to concurrent and prospective indicators of distress.

In the present study, we tested three hypotheses. First, we expected evidence for convergence or transmission concerning cognitive appraisals of the episode as stress-related (i.e., involving loss, harm, or threat). Although not explicitly tested, we assumed appraisal transmission to be triggered by direct communication between partners. In our second hypothesis, transmission of depressive symptoms between spouses over the course of the treatment were expected. Because of inconsistent evidence for gender or role effects in the transmission of depressive symptoms (e.g., Benazon & Coyne, 2000; Joiner & Katz, 1999), this hypothesis was not further specified with regard to gender or role differences in transmission. In our third hypothesis, we assumed that in addition to the direct transmission of stress appraisals and depressive symptoms, partners might also take each others' earlier depressive symptoms as cues for their own subsequent stress appraisals. That is, higher levels of earlier depressive symptoms of one partner should predict more intense stress appraisals in the other partner at a later point in time, which, in turn, would be associated with changes in this same partner's depressive symptoms.

Method

Design and Participants

Data were assessed at three points in time (upon oocyte and sperm collection, after the embryo transfer, and following the first pregnancy test) to capture stages of the treatment process that have been described to place qualitatively and quantitatively differing demands on couples (e.g., Eugster & Vingerhoets, 1999). (1) Oocyte and sperm collection

mark the end of a treatment phase that is characterized by frequent contacts with the fertility clinics and compliance with a complex treatment regimen. Compared with later phases of the treatment, up to this point couples have relatively higher control over the success of the intervention. (2) Following the embryo transfer, however, a waiting period sets in that is characterized by a lack of control over the outcome and higher distress. (3) Finally, following the pregnancy test, couples have to come to terms with the immediate outcome of the treatment, i.e., cope with a negative outcome or adjust to pregnancy.

Data were assessed at four fertility clinics in four German cities. An institutional review board approved the procedure. Couples were approached on the day of oocyte and sperm collection by medical personnel working at the respective clinics (Time 1, T1). They were handed study materials, asked to give their written consent to participation in the study, and instructed to complete the T1 questionnaires independently from one another. Materials included a detailed description of the confidentiality rules and study procedure, which instructed the couples to give written consent, to complete the questionnaires independently from one another while still at the clinic, seal the consent forms and questionnaires in different return-envelopes provided, and leave all materials at the clinic. At the second (Time 2, T2; after the embryo-transfer, i.e., 7 days after T1) and third (Time 3, T3; after the pregnancy test, i.e., 4 weeks after T2) measurement points, all couples received questionnaires and stamped return-envelopes via mail. Medical data were retrieved from the couples' records by a study investigator.

A total of 82 couples consented to participate in the study. Of these, 65 couples were married. Thirty couples underwent *in vitro* fertilization (IVF) treatment and 51 couples received ICSI treatment (for one couple, the type of treatment could not be determined). Among women, mean age was 34.48 years ($SD = 4.60$; age range 23–44 years) and an average of 12.08 years of schooling ($SD = 1.36$) was reported. Men's mean age was 36.83 ($SD = 5.23$; age range 26–55 years) and they reported 11.55 ($SD = 1.54$) years of schooling. Fifty-one couples had not undergone an IVF/ICSI treatment before, and 22 (27%) women became pregnant as a result of this treatment cycle. Couples had been in a relationship for a mean of 9 years ($SD = 5.45$). Most couples (80%) had attempted pregnancy for up to 5 years, 20% for longer than 5 years. Fourteen couples had children prior to this treatment.

All couples provided T1 data, 70 couples (85%) provided T2 data, and 62 couples (76%) provided T3 data. Continuing and noncontinuing couples did not differ with respect to age, marital status, education, number of children, pregnancy outcome, or type of treatment. Continuing couples were, however, more likely to be experiencing their first treatment cycle, and the husbands of continuing couples had more initial objections about the treatment (as rated by their spouses) and tended to believe less in chance-control of the treatment's outcome. To account for the pat-

tern of missing data, we employed multiple imputation (NORM 2.03; Schafer, 1999), including this study's central variables as well as variables associated with missingness in the imputation model. Multiple imputation (MI) is a Monte-Carlo technique that takes into account the missing data uncertainty by generating multiple values for respective points of missing data, thereby creating multiple data sets. Each of these data sets is then analyzed separately. Results are integrated in a last step by means of a method proposed by Rubin (1987) to obtain overall estimates and standard errors. MI, thus, reflects the uncertainty of missing data by introducing between-imputation variance. In this study, 10 imputed data sets were generated and analyzed.

Measures

Depressive Symptoms

For the assessment of depressive symptoms, the German version of the Center for Epidemiological Studies Depression scale (CES-D; Hautzinger, 1988; Radloff, 1977) was used. The scale comprises 20 items. Participants were asked to rate the frequency of occurrence of depressive symptoms during the past week ranging from 0 = *less than a day* to 3 = *most of the time (5 to 7 days)*. The total sum score may, thus, range between 0 and 60. Internal consistencies ranged between Cronbach's $\alpha = .87$ and $\alpha = .94$ in women, and from $\alpha = .70$ to $\alpha = .84$ in men.

Stress Appraisals

Loss and threat appraisals were assessed using an abbreviated and adapted scale by Jerusalem (1990). The appraisal items from the original version were adapted to avoid affect-related wording. The scales consisted of three items each (see also, Knoll, Schulz, Schwarzer, & Rosemeier, 2006), e.g., "This situation already restricts my life very much" (harm/loss appraisal), "I might not be able to cope with the demands of the situation" (threat appraisal). Because factor analyses indicated that threat and loss appraisal items loaded on one factor at most measurement points in time and because this was the case for women and men alike, items were pooled in one scale that will, henceforth, be called stress appraisals. Participants were instructed to appraise their own situation with regard to the assisted-reproduction treatment *at that moment*. Items were rated on 4-point Likert-type scales ranging from 0 = *does not apply at all* to 3 = *applies exactly*. Cronbach's α s ranged between $\alpha = .86$ and $\alpha = .96$ in women and $\alpha = .71$ and $\alpha = .76$ in men.

Analyses

Testing tentative predictive direction among stress appraisals and depressive symptoms in women and men separate-

ly, we employed cross-lagged manifest path models, using AMOS 6.0. To analyze transmission processes we used a model proposed by Kenny and colleagues, i.e., the actor-partner interdependence model (APIM; e.g., Cook & Kenny, 2005). In the APIM, actors' outcomes are predicted by their own variables as well as by those of their partners. Effects of actors' predictors on their own outcomes are called *actor effects*; effects of partners' variables on actors' outcomes are referred to as partner effects. Following recommendations by Cook and Kenny (2002), we used the couple as the unit of analysis and performed path analyses using AMOS 6.0. In accord with suggestions by Kenny, Kashy, and Cook (2006) concerning the use of pathmodels when fitting the APIM we left coefficients in dyadic models unstandardized, as common standardization procedures would render the coefficients incomparable among partners. To integrate estimates that were generated from multiply imputed data sets, we used the scalar MI inference function featured by NORM (2.03; Schafer, 1999). To integrate χ^2 model fits where applicable, we used a SAS macro designed by Allison (2007) on the basis of work by Schafer (1997). This macro integrates multiple χ^2 s and associated degrees of freedom yielding an F value, numerator and denominator degrees of freedom, and a significance value.

Results

Correlations and Descriptives

Women's correlative stabilities of depressive symptoms ($r_{T1-T2} = .53$, $r_{T2-T3} = .40$) and stress appraisals ($r_{T1-T2} = .66$, $r_{T2-T3} = .52$) were medium in size, the respective means increased from oocyte retrieval until after the embryo transfer (depressive symptoms: $t(216_{MI}) = -2.50$, $p < .05$; stress appraisals: $t(826_{MI}) = -2.46$, $p < .05$ see Table 1), but remained stable thereafter. Also, cross-sectionally, women's depressive symptom scores were highly positively correlated with their own stress appraisal scores with $r_{T1} = .60$, $r_{T2} = .71$, and $r_{T3} = .77$.

Men's correlative stabilities of depressive symptoms ($r_{T1-T2} = .51$, $r_{T2-T3} = .67$) and stress appraisals ($r_{T1-T2} = .51$, $r_{T2-T3} = .70$) were in a medium to high range; their respective means remained stable. Cross-sectionally, men's correlations between stress appraisals and depressive symptoms were positive and medium in size with $r_{T1} = .39$, $r_{T2} = .54$, and $r_{T3} = .36$.

To test tentative predictive direction between stress appraisals and depressive symptoms within persons, two cross-lagged manifest path analyses (T1 to T2, T2 to T3) were conducted for women and men each. Cross-lagged paths did not differ significantly in men; neither did they differ in women between T2 and T3. However, restricting T1 to T2 cross-lagged paths to be equal in women was associated with an unsatisfactory integrated model fit,

Table 1. Women’s and men’s correlations, means, and standard deviations of the study’s central variables

	1	2	3	4	5	6	7	8	9	<i>M (SD)</i> Women	<i>M (SD)</i> Men
1 Depressive symptoms T1	.35	.51	.47	.39	.31	.18	-.10	-.35	.02	16.11 (8.77)	10.11 (5.18)
2 Depressive symptoms T2	.53	.22	.67	.28	.54	.38	-.08	-.05	-.00	19.27 (11.63)	11.57 (8.07)
3 Depressive symptoms T3	.22	.40	.62	.22	.40	.36	-.13	-.00	-.01	18.38 (14.25)	11.27 (6.81)
4 Stress appraisals T1	.60	.54	.26	.13	.51	.45	.00	-.08	.12	0.64 (0.59)	0.36 (0.39)
5 Stress appraisals T2	.38	.71	.29	.66	.29	.70	-.13	.23	.03	0.81 (0.73)	0.43 (0.42)
6 Stress appraisals T3	.19	.42	.77	.40	.52	.46	-.03	.14	-.11	0.83 (0.77)	0.44 (0.40)
7 Already children (yes/no)	-.05	-.14	-.11	-.01	-.16	-.07	-	.02	-.06	14 couples had children	
8 ICSI (yes/no)	-.06	-.04	-.09	-.09	.09	.03	.02	-	-.19	51 couples received ICSI	
9 Pregnancy (yes/no)	.05	-.02	-.13	-.02	-.05	-.25	-.06	-.19	-	22 became pregnant	

Note. *N* = 82 couples. ICSI: intracytoplasmic sperm injection. Below the diagonal: women’s coefficients. Above the diagonal: men’s coefficients. Diagonal (shaded): women’s and men’s scores correlated. All coefficients > .19 are significant at *p* ≤ .10; all coefficients > .24 are significant at *p* ≤ .05.

Table 2. Cross-lagged path coefficients indicating within-person relationships among women’s (Models 1 and 3) and men’s (Models 2 and 4) stress appraisals and depressive symptoms, using the individual as unit of analysis

	W Stress appraisals T2		W Depressive symptoms T2		Integrated multiple model fits ^b
<i>Model 1^a women</i>	<i>B (SE)</i>	β	<i>B (SE)</i>	β	<i>F (df)</i>
IVs:					
W Stress appraisals T1	.91 (0.15)***	.68	6.98 (2.28)**	.35	
W Depressive symptoms T1	-0.00 (0.01)	-.04	0.42 (0.15)**	.32	8.53 (1, 912.16)**
	M Stress appraisals T2		M Depressive symptoms T2		
<i>Model 2^a men</i>	<i>B (SE)</i>	β	<i>B (SE)</i>	β	
IVs:					
M Stress appraisals T1	0.49 (0.12)***	.46	2.00 (2.43)	.09	
M Depressive symptoms T1	0.01 (0.01)	.13	0.74 (0.17)***	.48	0.69 (1, 243.84)
	W Stress appraisals T3		W Depressive symptoms T3		
<i>Model 3^a women</i>	<i>B (SE)</i>	β	<i>B (SE)</i>	β	
IVs:					
W Stress appraisals T2	0.44 (0.15)**	.45	0.14 (3.08)	.11	
W Depressive symptoms T2	0.01 (0.01)	.01	0.49 (0.22)*	.40	0.15 (1, 441.14)
	M Stress appraisals T3		M Depressive symptoms T3		
<i>Model 4^a men</i>	<i>B (SE)</i>	β	<i>B (SE)</i>	β	
IVs:					
M Stress appraisals T2	0.65 (0.10)***	.69	0.76 (1.87)	.05	
M Depressive symptoms T2	0.00 (0.01)	.01	0.55 (0.11)***	.65	0.27 (1, 778.49)

Note. *n* = 82 women and *n* = 82 men. **p* < .05, ***p* < .01; ****p* < .001. W = women; M = men. IVs: Independent variables. *B* = unstandardized coefficients, *SE* = standard errors, β = standardized coefficients. *df* = degrees of freedom. T1 = oocyte retrieval, T2 = after embryo transfer, T3 = after pregnancy test. *R*² women: Stress appraisals T2 = .44, T3 = .28; depressive symptoms T2 = .36, T3 = .17. *R*² men: Stress appraisals T2 = .27, T3 = .50; depressive symptoms T2 = .28, T3 = .46. a: Integrated parameter estimates from fully saturated manifest pathmodels. b: $\chi^2 dif$ (*df* = 1) if cross paths restricted to be equal. Models generated from 10 multiply imputed data sets each, integrated with a method proposed by Schafer (1997; see also Allison, 2000).

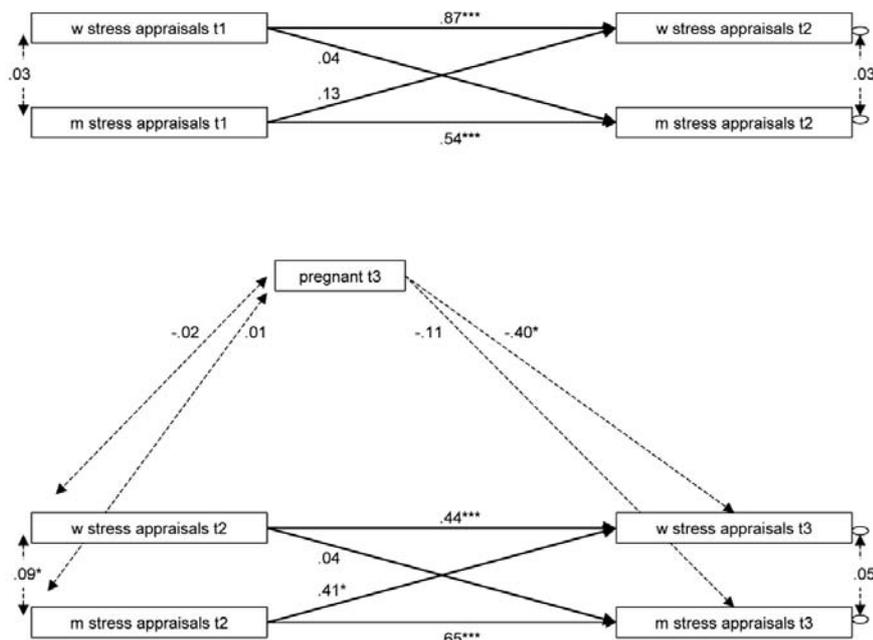


Figure 1. Actor-Partner-Interdependence Model: Fully saturated manifest path model of relations among T and T-1 stress appraisals of women (w) and men (m). Path coefficients are unstandardized. R^2 women's stress appraisals = .45 (T2), .38 (T3); R^2 men's stress appraisals = .26 (T2), .56 (T3). T1 = oocyte retrieval, T2 = after the embryo transfer, T3 = after the pregnancy test. * $p \leq .05$; *** $p < .001$.

$F(1, 912.16) = 8.53, p < .01$. Coefficients indicated that women's stress appraisals at T1 positively predicted residualized changes in depressive symptoms from T1 to T2. This effect was significantly stronger than depressive symptoms at T1 predicting respective changes in stress appraisals (see Table 2).

Degrees of cross-sectional overlap among partners' stress appraisals and depressive symptoms varied over time (see Table 1, shaded diagonal), however, all coefficients were positive. Nonindependence in depressive symptoms varied between $r = .22$ ($p < .10$) and $r = .62$. Nonindependence in stress appraisals was nonsignificant at T1 and low to medium at T2 ($r = .29$) and T3 ($r = .46$; unless indicated otherwise, all significant at $p < .05$).

Stress Appraisals and Depressive Symptoms: Evidence of Transmission?

Evidence of transmission of partners' stress appraisals over time was weak. From oocyte retrieval (T1) until after the embryo transfer (T2), no significant transmission effects were observed. However, men's stress appraisals following the embryo transfer positively predicted residualized changes in women's stress appraisals following the pregnancy test ($p = .050$; see Figure 1). For the 10 multiply imputed data sets, 10 model comparisons of the fully saturated model to a model restricting partner effects to be equal yielded χ^2 differences between .83 and 9.34 with one degree of freedom each (Cook & Kenny, 2005). These were then integrated using the macro developed by Allison (2000), which yielded an integrated $F(1, 112.97) = 2.97, p = .088$. Partner-effect coefficients, thus, differed at $p < .10$ only.

More consistent evidence of transmission emerged with respect to changes in depressive symptoms. In all models, men's earlier depressive symptoms positively predicted changes in women's depressive symptoms, both at $p = .051$ (see Figure 2). Also, restricting the partner-effects of models to be equal yielded unsatisfactory model fits; Model T1 to T2: integrated χ^2 s yielded $F(1, 89.00) = 5.00, p < .05$; Model T2 to T3: integrated χ^2 s yielded $F(1, 32.45) = 3.97, p = .054$. Thus, hints of gender or role differences in transmission emerged for both stress appraisals and depressive symptoms.

Depression Transmission: Evidence of Indirect Effects via Stress Appraisals?

To test possible indirect effects of depression transmission via partners' stress appraisals, we expanded the actor-partner depressive-symptoms models to include both partners' stress appraisals at the respective outcomes' time points (see Figure 3).

From oocyte retrieval (T1) until after the embryo transfer (T2), both actors' earlier depressive symptoms were positively associated with their own T2 stress appraisals, which in turn positively predicted their own residualized depressive symptoms at T2 (indirect effects: women, Sobel $z = 2.39, p < .05$; men, Sobel $z = 2.26, p < .05$). Moreover, men's T1 depressive symptoms predicted higher levels of women's T2 stress appraisals, which, as described above, were positively associated with women's own residualized T2 depressive symptoms (indirect effect Sobel $z = 2.00, p < .05$). Additionally, the former direct transmission effect from men's T1 depressive symptoms to women's T2 changes of depressive symptoms was no longer significant.

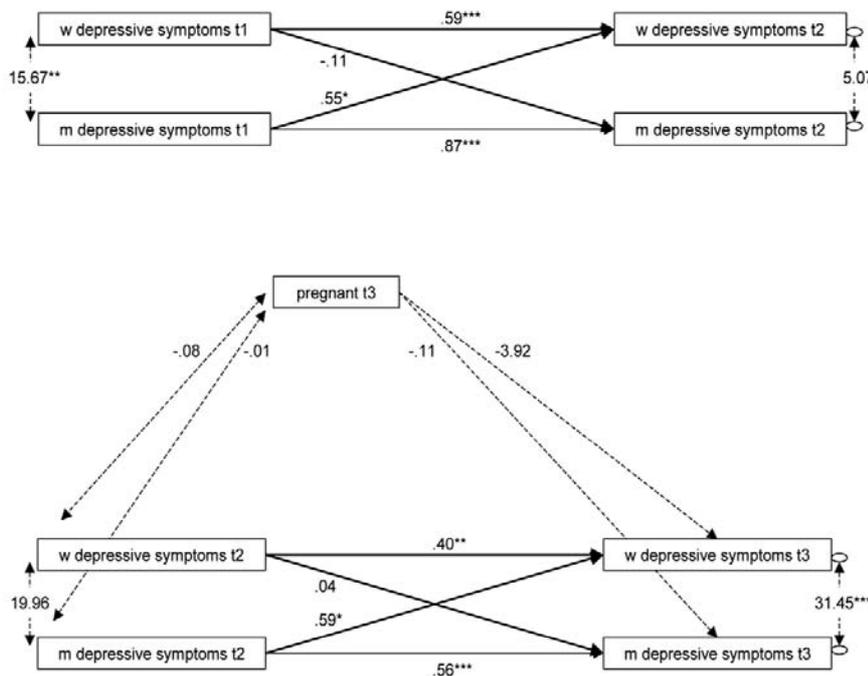


Figure 2. Actor-Partner-Interdependence Model: Fully saturated manifest path model of relations among T and T-1 depressive symptoms of women (w) and men (m). Path coefficients are unstandardized. R^2 women's depressive symptoms = .30 (T2), .29 (T3); R^2 men's depressive symptoms = .28 (T2), .46 (T3). T1 = oocyte retrieval, T2 = after the embryo transfer, T3 = after the pregnancy test. * p = .05; ** p < .01; *** p < .001.

From embryo transfer (T2) until after the pregnancy test (T3), women's positive indirect actor effect remained (Sobel $z = 3.14, p < .01$), as did evidence for indirect transmission between men's T2 depressive symptoms and women's residualized depressive symptoms (T3) via women's T3 stress appraisals (Sobel $z = 2.14, p < .05$; all effects were positive in direction; see Figure 3B). Additionally, two other indirect effects emerged. As women's T2 depressive symptoms were positively associated with their own T3 stress appraisals, these, in turn, predicted higher residualized depression scores in their partners (Sobel $z = 2.55, p < .05$). Also, while men's depressive symptoms at T2 predicted women's T3 stress appraisals, they, in turn, were positively associated with men's residualized depressive symptoms at T3 (Sobel $z = 1.93, p = .054$).

Discussion

In this study we tested transmission effects of stress appraisals and depressive symptoms among partners undergoing assisted-reproduction treatment. Findings indicated only partial support for the the first assumption regarding transmission of stress appraisals. Only one transmission effect of stress appraisals from men to women from before until after the first pregnancy test was found. From women to men, however, transmission of stress appraisals could not be observed. Also only partly in accord with Hypothesis 2, transmission of depressive symptoms from men to women, but not from women to men, was observed across both measurement intervals. Supporting assumptions by Bodenmann's dyadic coping model (e.g., 1997) and in ac-

cord with Hypothesis 3, the transmission of men's depressive symptoms to women seemed to be mediated by women's stress appraisals. Thus, when accounting for women's stress appraisals, men's earlier depressive symptoms were no longer directly related to residualized increases in women's depressive symptoms. As stated before, a likely explanation could lie in the cue function of men's depressive symptoms for their partners in this situation. Their partners' depressive symptoms could also have produced additional worries for women, leading them to appraise the situation as more stressful. Especially with regard to women's convergence with their partners' stress appraisals, open communication between partners about the stakes of the situation should be a plausible mediator.

Predictive patterns for men did not support our hypotheses. In models separately testing interrelations among both partners' stress appraisals (Figure 1) or depressive symptoms (Figure 2), no direct transmission effects from women to men were observed. When appraisals were added to models that tested residualized changes in depressive symptoms (see Figure 3), again, men's patterns of effects were not in line with predictions. At no time were women's earlier depressive symptoms predictive of men's later stress appraisals.

The apparent gender or role difference in this pattern of findings, i.e., women's seemingly more thorough or longer-lasting processing of their partners' depressive symptoms, was unexpected. Benazon and Coyne (2000) suspected that women have a greater propensity to become distressed themselves when members of their close network are depressed because of women's stronger orientation to the needs of their intimates (Ickes, Gresn, & Graham, 2000). Should a gender effect in couples' transmission dur-

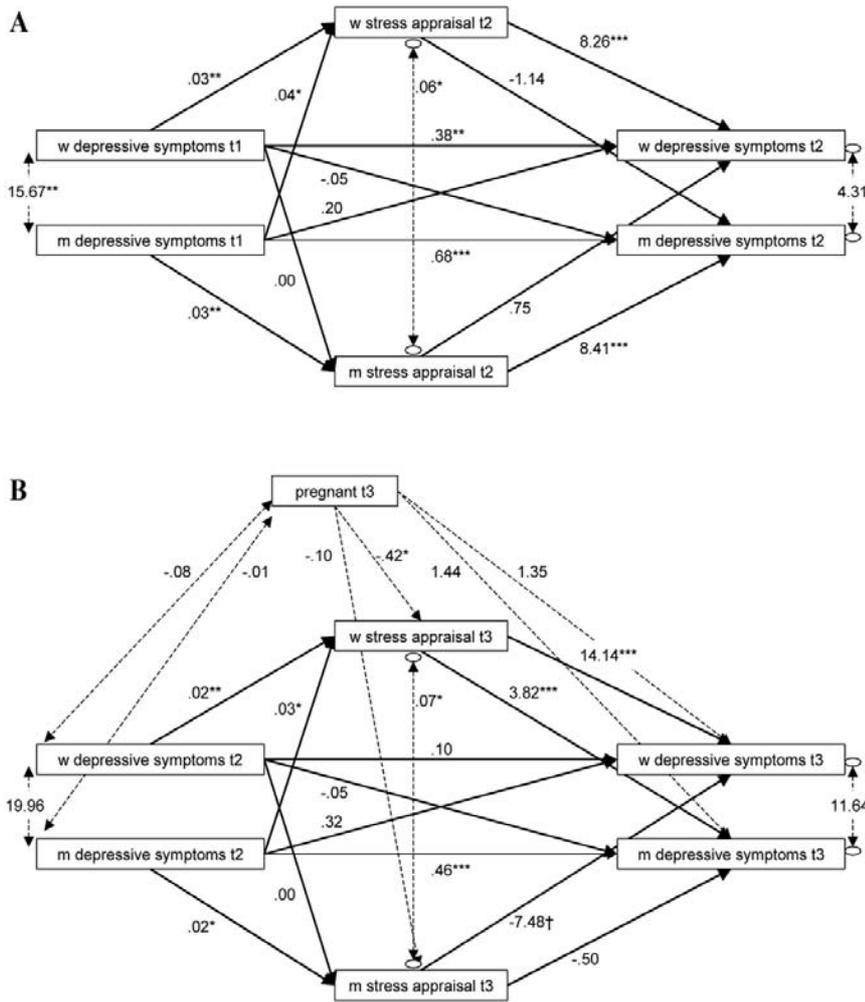


Figure 3. Fully saturated manifest path model of relations among T1 and T2 depressive symptoms and T2 stress appraisals (A) and among T2 and T3 depressive symptoms and T3 stress appraisals (B) of women (w) and men (m). Path coefficients are unstandardized. (A) R^2 women's T2 stress appraisals = .20, R^2 women's T2 depressive symptoms = .44; R^2 men's T2 stress appraisals = .10, men's T2 depressive symptoms = .44. (B) R^2 women's T3 stress appraisals = .32, R^2 women's T3 depressive symptoms = .66; R^2 men's T3 stress appraisals = .18, R^2 men's T3 depressive symptoms = .59. T1 = oocyte retrieval, T2 = after the embryo transfer, T3 = after the pregnancy test. † $p < .10$; * $p < .05$; ** $p \leq .01$; *** $p < .001$.

ing real-life stress episodes hold, this explanation could account for the effect. However, empirical findings concerning gender differences in emotional transmission remain equivocal. For instance, Joiner and Katz's (1999) general findings from a meta-analysis did not yield reliable gender differences, with a few exceptions suggesting even a higher propensity for men to be vulnerable to women's depressive symptoms.

More importantly, the context of this study might explain why men's appraisals were not directly or enduringly associated with their partners' earlier depressive symptoms. Repeatedly reported side effects of hormonal stimulation treatments include elevated depression (Berghuis & Stanton, 2002; Eugster & Vingerhoets, 1999). With a readily available external cause for distress, men might have attributed much of their partners' emotional development throughout the treatment to the preceding hormonal stimulation. We could not directly test this explanation. However, couples are routinely informed about the possible side-effects of the different treatment phases and, thus, awareness about them seems likely. In a daily diary study, Thompson and Bolger (1999) found that partners of target persons who were preparing to take an important exam

were less and less affected by their partners' emotions as the exam drew closer. The authors suggested that the partners' attributions for the examinees' emotions refocused from the examinee to the exam as the approaching external stressor.

That men's emotional reactions after the pregnancy test seemed to be associated with their partners' appraisals more so than with their partners' earlier depressive symptoms, might also indicate a possible externalized attribution. Two indirect effects via women's appraisals predicted increases in men's depressive symptoms from prior to until after the pregnancy test. The first one led from women's earlier depressive symptoms, via women's later stress appraisals, to residualized increases in men's depressive symptoms. Note that there had not been a prior direct effect from women's earlier depressive symptoms to men's increases in depressive symptoms. The second indirect effect led from men's earlier depressive symptoms, again via women's later stress appraisals, to men's residualized depressive symptoms. If men reacted to their partners' cognitive appraisal as opposed to the depressive symptoms their partners had exhibited earlier, they could have done so in an effort to protect the relationship by making allow-

ances for their partners emotional reactions. Note, however, that the latter two findings, as well as the other indirect effects, remain inconclusive because of the same-time assessment of appraisals (as proposed mediators or indirect effects) and depressive symptoms (as outcomes). Essentially, the pattern of findings could also imply that men were affected by their partners' variables only after the pregnancy outcome was known.

In addition to indirect effects involving partner variables, pure actor effects with regard to appraisal – depressive symptoms associations also emerged. From oocyte retrieval until after the embryo transfer, both women's and men's residualized increases in depressive symptoms were partly accounted for by their own stress appraisals at the latter assessment. The same was true for women's effects from after the embryo transfer until after the first pregnancy test. These actor effects might hint at the reciprocal effects of appraisals and well-being outcomes in the transactional stress model (Bodenmann, 1997; Lazarus & Folkman, 1987). However, stronger evidence for reciprocal effects should have emerged in cross-lagged path models. Here, the prediction of changes in appraisals and depressive symptoms by the respective other variable was tested. In the present cross-lagged analyses, however, no evidence of reciprocal effects emerged, which was likely the result of the long intermeasurement intervals. Only one significant cross-lagged effect indicated that women's earlier appraisals predicted residualized increases in their own depressive symptoms, thus, tentatively supporting one key assumption of the transactional model of stress (Lazarus & Folkman, 1987).

Finally, results indicate that women's cross-sectional associations between appraisals and depressive symptoms at T2 (after the embryo transfer) and T3 (after the pregnancy test) were unusually high. Such high associations between appraisals and depressive symptoms, especially at time points with the highest levels of depressive symptoms, might hint at stress-related de-differentiation. Arguing in favor of de-differentiation under stress, Zautra, Reich, Davis, Potter, and Nicolson (2000) cite a number of findings, pointing to increases in dependence of positive and negative affect in demanding situations. They explain this transient structural change by stress-related changes in information processing. Also, Linville (1985) proposes that attentional focus narrows under stressful circumstances, eventually leading to a reduced capacity to form complex judgments, which in turn results in more unified responses. This explanation is backed by Linville's finding that normally unrelated cognitive processes are substantially intercorrelated under stress, which indicates a shrinkage of informational space.

Limitations and Suggestions for Future Research

This study has a number of limitations. Couples were approached and recruited by medical personnel from the re-

spective fertility clinics. To limit interference of the study's recruiting procedure with clinical routines, information on the exact number of refusals was not recorded. An estimate of the percentage of couples who agreed to participate in the study is 30%, varying between approximately 10% and 40% among the clinics. Because comparatively few couples agreed to participate, the generalizability of the present findings to the population of couples undergoing IVF/ICSI treatments might be questioned. Hence, part of the available medical data of the participating couples were compared to data from a national sample published by the German IVF Register (2006). In the present study, 27% of the women became pregnant as a result of this treatment cycle, which roughly coincided with the average success rate of IVF/ICSI treatments in Germany for 2005 (i.e., 28.69%). Moreover, 63% of couples underwent ICSI treatments, which is only slightly less than the proportion of the national sample in 2005 (i.e., 68.59%). Also, of the couples who received ICSI treatments, 3.9% of men presented with azoospermia as compared to 4.12% in the national sample. Thus, concerning medical data, similarities between the present sample and a national sample of IVF/ICSI couples are evident.

We used manifest cross-lagged path analyses to test the tentative predictive direction of the variables under study. Cross-lagged regression or manifest path models have received much criticism. As was done in the current paper, discrete time modeling of individual and couple processes tends to be an oversimplification of reality. The oversimplification consists in the suggestion that the associations jump from one point in time to the next one and that nothing happens between measurements (Delsiing, Oud, & De Bruyn, 2005). Instead, the estimated cross-lagged coefficients over the measurement interval are complicated mixtures of the continuous-time cross-lagged and autoregressive effects in a constant interchange. They are moreover heavily dependent on the length of the observation interval chosen (Delsiing et al., 2005). This sample criticism holds for many longitudinal designs and associated data analyses and is also closely related to another limitation of this study. As stated above, in models containing both appraisals and depressive symptoms, the presumed indirect effects and outcomes were assessed at the same time. Evidence for the proposed predictive direction between stress appraisals and outcomes was sparse (see Table 2), probably because of the fairly long intermeasurement lags. Although with the present data structure we cannot specifically address the problems associated with cross lagged- models and length of measurement interval, future studies with diary designs could make model testing more efficient and could better account for the process character of stress and transmission among partners.

To follow-up the implication of external attributions on the transmission of emotions in couples under stress, experimental designs that counter-balance target-person gender and vary the degree of external attributions for one's partners' distress symptoms might help to clarify two ques-

tions. First, as Thompson and Bolger (1999) suggested, one could isolate the role that external attributions play in the contagion of distress symptoms. Second, one could begin to test whether gender differences emerge in emotional transmission and whether or not they possibly moderate the association between the degree of readily available external attribution and the intensity of emotional transmission.

Conclusions

Evidence was found for the transmission of depressive symptoms from men to women at different phases of assisted-reproduction treatment. Transmission appeared to be indirect, in that women's stress appraisals accounted for parts of the effects. Within the depressive symptoms or appraisal domains, no transmission processes from women to men were observed. Investigating cognitive mediators of emotional transmission in a transactional framework of stress could help to further identify partners' strategies to protect not only their own, but also their spouses' emotional well-being in times of stress. In addition, the investigation of cognitive processes that mediate emotions in partners should help to gain a better understanding of the phenomenon of transmission. Finally, couple interventions enhancing partners' awareness of reasons for differences in emotional involvement within stressful situations might help to reduce marital distress.

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