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Self-Determination Theory and Computer-Mediated Support: Modeling Effects on Breast Cancer Patient's Quality-of-Life

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ABSTRACT

A breast cancer diagnosis typically results in dramatic and negative effects on an individual's quality of life. Web-based interactive support systems such as the Comprehensive Health Enhancement Support System (CHESS) offer one avenue for mitigating these negative effects. While evidence supports the efficacy of such systems, evaluations typically fail to provide a true test of the theorized model of effects, treating self-determination theory's constructs of competence, relatedness, and autonomy as outcomes rather than mediators. Using path analysis, this study tests the nature of the proposed mediated relationship between system engagement and quality-of-life indicators utilizing data collected from women ($N = 90$) who participated in the treatment condition of a CHESS randomized controlled trial. Findings support a latent model, indicating that system effects are mediated through an intertwined measure of autonomy, competence, and relatedness.

Breast cancer is the second leading cause of cancer deaths among women in the United States (American Cancer Society, 2014). Pain, depression, isolation, weight instability, and other symptoms associated with decreased quality of life are commonly reported as adverse side effects of the cancer diagnosis and treatment (Andersen, 1992; Wahnefried, Rimer, & Winder, 1997). The provision of informational, emotional, and social support can buffer the extent to which these challenges erode quality of life (Han et al., 2011). Communication technologies that provide support can—and do—enhance quality of life for women experiencing breast cancer (Pingree et al., 2010; Shaw, McTavish, Hawkins, Gustafson, & Pingree, 2000).

According to self-determination theory (SDT), quality of life is largely determined by the extent to which individuals' psychological needs are met (Ryan & Deci, 2000a, 2000b). These psychological needs—competence, relatedness, and autonomy—are prerequisites to positive human development, and can be promoted through numerous channels. Patient-centered computer-mediated communication interventions guided by SDT have been shown to result in improved physiological and psychological outcomes (Gustafson et al., 2001). For instance, randomized controlled trials have tested the utility of an interactive communication system called the Comprehensive Health Enhancement Support System (CHESS), which is designed to address the psychological needs described in SDT (Gustafson et al., 2008).

Mounting evidence suggests that engagement with computer-mediated support systems, particularly CHESS, leads to enhanced quality of life (Gustafson et al., 2008; Hawkins et al., 2010). These findings are promising insofar as they demonstrate the efficacy of the CHESS intervention. However, understanding the mechanisms through which this online support system enhances health outcomes for individuals experiencing a health crisis is equally important (Han et al., 2011). Understanding the process facilitates effective replication and theory testing (Stephenson, Holbert, & Zimmerman, 2006), and enhances the likelihood that any existing intervention effects will be detected through statistical analysis (Hornik, 2002).

It is notable, then, that only one of the aforementioned CHESS evaluation studies using SDT as the guiding framework has tested whether the SDT constructs mediate any improved health outcomes resulting from system use. Hawkins and his colleagues (2010) tested the mediating role of SDT components as separate, distinct contributors to health outcomes, but did not account for the likelihood that the constructs inherent in the model could be intertwined in important ways. Analyses that do not account for the potentially interrelated nature of the mediating variables may not adequately capture the impact of intervention activities. Thus, while evidence is mounting with respect to whether an SDT guided intervention promotes positive health and well-being, how particular components of SDT contribute

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to these outcomes is less clear. This study aims to identify the relationship between engagement with the CHESS online cancer support system, the psychological needs inherent in SDT, and quality of life.

This study extends previous research by (a) simultaneously testing the SDT pathways as mediators of the effects of the online support system on quality-of-life indicators, (b) examining the relative strength of the pathways through which the intervention exerts its impact, and (c) testing competing models of mediation. Understanding the nature of the mediated relationships may shed light on the pathways to treatment effectiveness, and clarify whether particular features of the intervention (i.e., those that promote competence, autonomy, and relatedness) are optimally effective in and of themselves or when delivered in concert with one another. We aim to provide a clearer picture of the process by which an online cancer support system affects quality of life through self-determination.

Self-determination theory

Self-determination theory (Ryan & Deci, 2000a, 2000b) posits that human well-being, broadly defined, is determined by an individual's satisfaction of three essential psychological needs: autonomy, competence, and relatedness. Autonomy refers to the perceived locus of causality—an individual's perception that she has choices and control in her life. Competence refers to perceptions of one's own capabilities (Pingree et al., 2010). It is a notion akin to self-efficacy—one's perceptions that one has the relevant skills to accomplish goals (Bandura, 2004; Deci & Ryan, 2000). Autonomy refers to perceptions of having choices (i.e., agency), while competence refers to perceptions of having abilities to act on those choices. Conceptually but not functionally distinct from both of these, relatedness is a sense of support from and identification with those around you (e.g., parents, friends, colleagues). Autonomy, competence, and relatedness, then, lay down the necessary conditions for psychological well-being, comfort, and security (Deci & Ryan, 2000). Individuals who are more internally motivated to act, believe they have the necessary abilities to perform the action, and have strong social support are more likely to engage in action, maintain change over time (Ryan, Patrick, Deci, & Williams, 2008), and experience better quality of life (Wei, Shaffer, Young, & Zakalik, 2005).

SDT has been validated in a variety of contexts (Ng et al., 2012) and is a particularly well-suited framework for guiding communication interventions to improve health and well-being. Field studies and randomized controlled trials have demonstrated the utility of the SDT framework for improving mental health outcomes (i.e., depression, anxiety, and somatization; Ryan et al., 2008) and physical health outcomes (i.e., increased intake of healthy foods, reduction in smoking, and adherence to prescribed medications; Williams et al., 2006). In the context of a breast cancer diagnosis, improving quality of life for women may similarly be associated with fulfillment of these basic needs (Gustafson et al., 2008; Han et al., 2011). SDT implies that satisfying needs for control over one's life, illness, and/or treatment (autonomy), enhancing the perceived capacity to do something about the situation

(competence), and promoting feelings of connection and open communication among peers (relatedness), especially those relevant to the disease experience (Hawkins et al., 2010), may have positive consequences for quality of life.

Self-determination theory and CHESS

The CHESS system is specifically designed to support autonomy, competence, and relatedness. Guided by SDT, the online CHESS system was created and continually modified to promote quality of life through the provision of information services (i.e., questions and answers [Q&A], referral directory, library of high-quality information), communication services (i.e., discussion groups, personal stories), and decision services (i.e., action plans, decision aids; Baker et al., 2011).

Many of the evaluations of CHESS interventions have shown improved health outcomes by applying SDT constructs, such as perceptions of informational or emotional support, as outcome measures. For example, Baker and colleagues (2011) compared the relative effectiveness of different system components and found that the provision of informational and emotional support significantly improved outcomes such as health information competence. CHESS has also demonstrated effectiveness in terms of improving perceptions of social support and health care participation, as well as decreasing negative emotions among women with breast cancer (Gustafson et al., 2005). More recently, Gustafson and colleagues (2008) found that CHESS improves quality of life and social support at several months postintervention.

Previous research has examined use of the CHESS system as it relates to the constructs represented in SDT, but has not adequately tested the mediating role of these variables in channeling effects onto quality of life. Hawkins and colleagues (2010) demonstrated that, compared to women who did not receive access to the CHESS system, women who received CHESS plus a health mentor showed improved quality of life and that this relationship was mediated through competence, relatedness, and autonomy. However, as the authors note, there were significant limitations to the measure of autonomy, which was assessed using a measure of information overload. Further, those analyses considered the effects of each of the potential mediators independently of one another by testing three different mediation models—one for each mediator, rather than testing them under one model or allowing them to simultaneously influence each other (also see Gustafson et al., 2012).

It is critical to test the potential mediating mechanisms simultaneously—accounting for other mediators in the model—since the effects may be related (Stephenson et al., 2006). This approach overcomes serious limitations to understanding the underlying mechanisms by which SDT may affect quality of life. In adopting this approach, the current study extends previous findings by conducting a more rigorous test that includes all theoretically proposed mediators in the model to test their performance in concert.

Consistent with previous research, CHESS use should positively affect quality of life through the mechanisms proposed in SDT. It is plausible that effective use of the

CHESS system influences each of the SDT elements, which in turn affect quality of life in a discrete, parallel way, as previous research has assumed. However, it is plausible that the relationship among the SDT constructs is more complicated than previous research has assumed. It is likely that the SDT constructs are related to one another. For example, competence may be positively related to autonomy such that women who believe they have the skills and abilities to enact health-related decisions (competence) may also believe that they have control over their health related decisions (autonomy). In this case, the effects of the mediators may be discrete, but the mediators would be correlated. Alternatively, it is also possible that the SDT constructs have reinforcing or contingent relationships (Pingree et al., 2010; Ryan et al., 2008). For example, deficiencies (or abundance) in autonomy may undermine (or promote) competence. Similarly, any positive effects of an individual's belief in her ability to make health-related choices may be buffered if she does not believe she has the skills to enact those decisions. Likewise, a breast cancer patient's competence with respect to managing treatment decisions may be bolstered if she is surrounded by a supportive community of women who have experienced a similar health crisis.

Beyond considering that autonomy, competence, and relatedness may operate in parallel to channel effects of CHESS on quality of life, this study also tests the potentially interrelated nature of the three components of SDT. We conceptualize three competing models, which rely on different assumptions about the relationships between the SDT mediators. The first model assumes the SDT constructs are discrete and unrelated (henceforth, uncorrelated parallel model). The second model assumes that the mediating pathways are discrete, but related (henceforth, correlated parallel model). The third model assumes that the mediators are deeply intertwined and are therefore more appropriately operationalized as indicators of a latent construct—self-determination (henceforth, latent model; for a similar distinction see Dillard & Shen, 2005).

Hypotheses and research question

From this comparative perspective, this study evaluates the performance of the SDT components in each of the three models. However, prior to providing the rationale for this comparative hypothesis, we first hypothesize that the effects of CHESS on quality of life will be channeled through the three SDT components:

H1: The effects of CHESS system use on quality-of-life indicators (functional well-being, emotional well-being, depression, and breast cancer concerns) will be mediated through the SDT components (autonomy, competence, and relatedness).

Previous research may have overlooked important intervention effects by testing models that do not adequately capture the nature of relationships among the SDT components. As previous research has assumed, the effects of enhanced competence, autonomy, and relatedness on

quality of life may be discrete (i.e., uncorrelated parallel model). However, a model that allows for the mediating variables in the parallel model to intercorrelate is more theoretically consistent with the presumed structure of the relationships within SDT (i.e., correlated parallel model).

Taking this a step further, some conceptions of SDT assume that autonomy, competence, and relatedness are deeply intertwined in terms of their impact on quality of life. Indeed, Ryan and Deci (2000b) imply that the components of the model may be related to one another in a variety of mutually reinforcing ways. Based on this conceptualization of SDT, which is noted, but not tested in other research (Pingree et al., 2010; Ryan et al., 2008), competence, autonomy, and relatedness may be not only interrelated, but more deeply interconnected and mutually compensatory vis-à-vis their mediating effects on quality of life. Accordingly, the mediating role of SDT components in the relationship between CHESS use and quality of life should be more appropriately represented when autonomy, competence, and relatedness are understood as more, rather than less, interrelated. Specifically, the latent model should be superior to the correlated parallel model, which should be superior to the uncorrelated parallel model:

H2: The mediating components of SDT (autonomy, competence, and relatedness) will better explain the process by which CHESS system use affects quality-of-life indicators when the mediators are conceptualized as more, rather than less, deeply intertwined.

Illuminating the nature of mediated relationships has important implications for grasping whether particular components of the intervention may be especially effective for producing positive health outcomes. If a parallel model is supported, closer inspection of the simple indirect effects would suggest which mediators are most affected by the intervention and, in turn, which outcomes are most likely to be affected. If the latent model is supported, inspection of the factor loadings would suggest which mediators are most important in channeling intervention effects on quality-of-life outcomes. To gain a richer understanding of the process through which CHESS engagement affects quality of life, we examine the relative contributions of competence, autonomy, and relatedness.

RQ1: What is the relative contribution of the three SDT components (autonomy, competence, and relatedness) to quality-of-life indicators?

Method

Participants and procedures

Between July 1999 and March 2002, 238 patients with breast cancer diagnoses were recruited from cancer centers in Madison, WI, Cleveland, OH, Detroit, MI, and Rochester, MN. Clinicians introduced the study to patients who were female, breast cancer patients, not homeless, and able to give

informed consent. More than 81% of the invited patients agreed to participate across sites. Eligible participants who completed the pretest were retained for the study and randomized into a condition: CHESS access, Internet access, or control group. The study lasted 5 months.

The data reported here only include women in the CHESS intervention group who reported getting some information from the system ($N = 90$), since the concern in this article is with the mechanisms of effects rather than with establishing intervention efficacy per se (for intervention effects see Gustafson et al., 2008). The average age of participants was 51 years; about 75% had received post-high school education; median annual household income fell between $40,000 and $59,999; about one in five women lived alone; most received an early stage diagnosis (83.9%); and the average time since diagnosis to joining the study was 52 days.

CHESS intervention

The randomized controlled trial tested the efficacy of the CHESS Living with Breast Cancer program (Gustafson et al., 2005). The program was developed to offer a wide range of high-quality breast cancer information, online discussion groups with peer patients and experts, and interactive support tools (i.e., assessment charts; Gustafson et al., 2008). These services were designed to support autonomy, competence, and relatedness (Pingree et al., 2010).

Patients randomized into the CHESS treatment condition received, delivered to their home, computers for which the Internet connection was set up and paid during the intervention period. Women in the intervention condition were provided access (login ID and password) to the CHESS website and received 50 minutes of training on computer and Internet use.

Participants completed posttest surveys at 2, 4, and 9 months after the start of the intervention. The survey response rates were high, above 93% for each survey. This analysis is concerned with mediators of the effects of system use, which are expected to accumulate most dramatically during the initial intervention period (Baker et al., 2011), while participants have full access to the system and are dealing with the shock of diagnosis and treatment decisions. Consequently, analyses test whether CHESS system use increased autonomy, competence, and relatedness with data from 2- and 4-month surveys. For detailed information regarding randomization, training, and survey schedules, see Gustafson et al. (2008).

Measures

CHESS system use
Because this study aims to understand the mechanisms of CHESS system use effects, hypotheses are tested among women who reported "getting information from CHESS," on a scale from 1 (*a little bit*) to 4 (*very much*).

Quality of life
Four aspects of quality of life were measured using subscales from the Functional Assessment of Cancer Therapy-Breast (FACT-B; Cella et al., 1993), on a 5-point scale: $0 = not at all$, $1 = a little bit$, $2 = somewhat$, $3 = quite a bit$, $4 = very much$. These are a five-item *functional well-being* scale to assess the extent to which women perceive their ability to perform daily functions, like working and sleeping ($\alpha_{4\ m} = .89$); a four-item *emotional well-being* scale assessing the extent to which women feel sad, nervous, or worried about dying and their health ($\alpha_{4\ m} = .82$); two items assessing the extent to which women feel depressed about their life, which were combined to measure *depression* (reverse coded; $r_{4\ m} = .59$); and three items assessing concerns about body image, like feeling self-conscious about ways of dressing, feeling sexually attractive, and ability to feel like a woman, which were combined to represent *breast cancer-related concerns* (reverse coded; $\alpha_{4\ m} = .73$). When appropriate, items were reverse coded such that higher scores represent positive quality-of-life outcomes (i.e., low depression).

Self-determination
All SDT components were measured on a 5-point scale. For social support, the scale was $0 = not at all$, $1 = a little bit$, $2 = somewhat$, $3 = quite a bit$, $4 = very much$; for autonomy and competence it was $0 = disagree very much$, $1 = disagree$, $2 = neither$, $3 = agree$, $4 = agree very much$. A confirmatory factor analysis produced factor loadings that distinguished between autonomy, competence, and relatedness, thus confirming the performance of the SDT measures.[1] *Autonomy* was measured by asking participants to indicate how much they agreed with four statements assessing the degree to which they felt comfortable and confident being assertive, discussing treatment options and asking questions. These items are derived from the Health Care Climate Questionnaire (HCCQ; Williams, Freedman, & Deci, 1998; $\alpha_{2\ m} = .81$). As in previous research, the four-item *Competence* scale (Williams & Deci, 1996) assessed the extent to which women felt capable and knowledgeable with respect to their health ($\alpha_{2\ m} = .82$). *Relatedness* ($\alpha_{2\ m} = .87$) was constructed using the average of perceived social support and bonding scales. Both scales were developed in previous CHESS studies and were confirmed using confirmatory factor analysis (Gustafson et al., 2001, 2008). Social support was measured using a 6-item scale assessing the extent to which women perceived emotional and instrumental support ($\alpha_{2\ m} = .90$), and bonding was tapped on a 5-item scale assessing the extent to which women felt connected to other patients using the system ($\alpha_{2\ m} = .85$).

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[1] The second-order confirmatory factor analysis model contained the latent variable SDT made up of the three SDT components (autonomy, competence, and relatedness), which, in turn, were made up of their corresponding items (four, four, and 11, respectively; that is, social support and bonding combined under relatedness). The Comparative Fit Index indicated adequacy of the model (CFI = 1). Comparison with the baseline model indicated a significant improvement as indicated by AIC (15,585.98 in baseline vs. 10,107.03 in tested model) and BIC (15,689.96 in baseline vs. 10,271.04 in tested model) criteria (Kaplan, 2009).

All analyses controlled for age, education, income, race, health insurance status, whether participants experienced menopause, whether participants lived alone, stage of cancer development, and pretest values on the quality-of-life indicators.

Analysis

To test the mediating role of the SDT constructs in the relationship between the CHESS intervention and cancer patients' quality-of-life outcomes, we employed path analysis using Mplus v6. In each model, the effects of CHESS engagement on outcome variables measured at 4 months, controlling for the 2-month value of the outcome variable, were tested. Thus, the analysis tests whether changes in quality of life can be explained by the SDT mediators.

Within each model, mediation is tested based on significance and size of the specific indirect effects (Dillard & Shen, 2005; Kaplan, 2009, 2004), as well as overall fit of the model. Overall model fit is assessed using traditional model fit statistics (i.e., Comparative Fit Index [CFI], Tucker–Lewis Index [TLI], root mean square error of approximation [RMSEA]). Wald tests are used to test for differences among paths (for the parallel models) or differences among loadings (for the latent model) of SDT components.

Criteria for evaluating competing models

Path analysis allows for comparison of the uncorrelated and correlated parallel models (Jones et al., 2015) with each other and with a model in which the effects of the mediators are intertwined (i.e., a latent model) using the Akaike information criterion (AIC) and the Bayesian information criterion (BIC; Kaplan, 2009). Both the AIC and the BIC are comparative fit indices suitable for testing the relative fit of nested and nonnested models (Dillard & Shen, 2005). When comparing competing models, the model with the lowest criterion value is considered to be a better fit to the data (Kaplan, 2004; Kass & Raftery, 1995; Raftery, 1995). Research has shown that the BIC tends to penalize models with many parameters, while the AIC has been critiqued for favoring more complex models (Kass & Raftery, 1995). Thus, AIC and BIC together will provide a well-balanced test of our hypothesis. If each

criterion leads to the same conclusion, there is stronger evidence for model selection.

Results

The goal of this study is to examine whether and how the psychological needs for self-determination—autonomy, competence, and relatedness—mediate the relationship between engagement with an interactive cancer communication system and quality-of-life outcomes. Table 1 provides descriptive statistics, as well as correlations for key variables. Notably, on average women reported responses that were above the midpoint of the endogenous variables.

Parallel Models

Uncorrelated parallel model

CHESS system use had no direct effect on any of the quality-of-life outcomes (Figure 1) in the uncorrelated parallel model. Autonomy was significantly affected by engagement with the CHESS system (β = .25, p = .03). In turn, this construct had a direct effect on emotional well-being (β = .25, p = .03). System use was also associated with relatedness (β = .38, p = .00), which was in turn associated with functional well-being (β = .26, p = .03). While competence was not significantly associated with CHESS engagement, it was positively associated with functional well-being (β = .25, p = .01) and breast cancer-related concerns (β = .30, p = .00). No other effects were significant in this model.

Results from mediation analysis suggest that the effects of engagement with the CHESS system were mediated through relatedness, but not autonomy or competence. Specifically, the indirect effect from CHESS engagement to functional well-being was significantly mediated by perceptions of relatedness (Z = .10, p = .03). The indirect effect of intervention engagement on emotional well-being through autonomy was not significant (Z = .06, p = .09). No other indirect effects were significant for functional or emotional well-being, depression, or cancer concerns. This model suggests that any effects of the CHESS system engagement occur in the domain of functional well-being and are mediated through enhanced perceptions of relatedness.

Table 1. Correlation table.

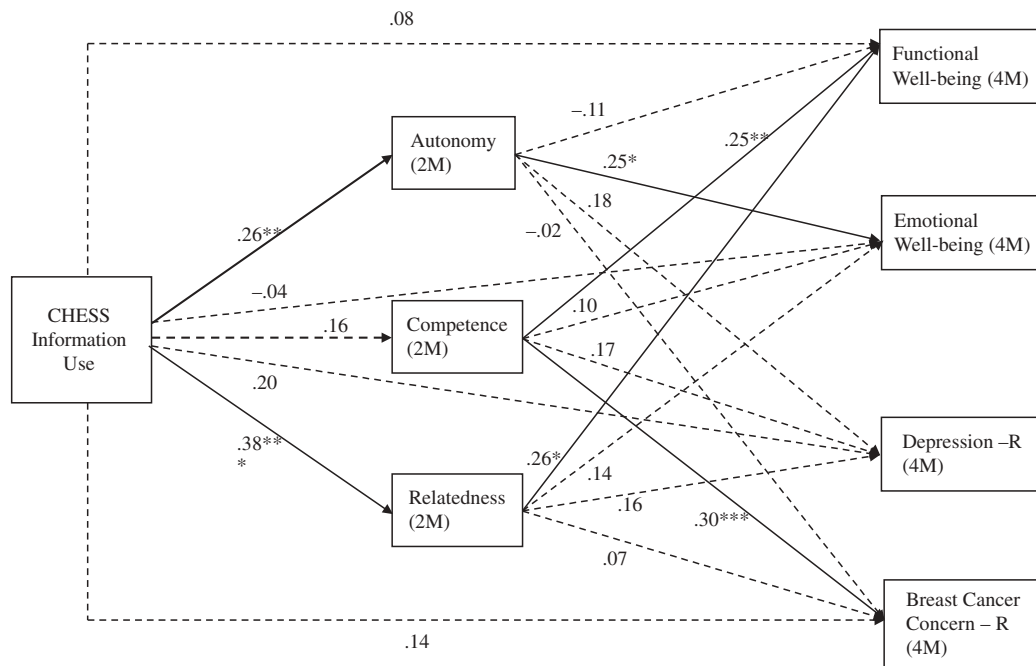|	Autonomy	Competence	Relatedness	FWB[1]	EWB[2]	Depression	BCC[3]	CHESS use
Autonomy	1.00							
Competence	.38**	1.00						
Relatedness	.60***	.45***	1.00					
FWB[1]	.21	.45***	.44***	1.00				
EWB[2]	.40***	.34***	.40***	.43***	1.00			
Depression	.32**	.35***	.51**	.57***	.62***	1.00		
BCC[3]	.24*	.47***	.33**	.49***	.46***	.41***	1.00	
CHESS use	.25*	.15	.28**	.12	.00	.25*	.17	1.00
Mean	3.29	2.73	3.11	2.91	2.82	3.29	2.44	3.24
SD	.61	.69	.60	.83	.76	.94	.82	.85

Note. N = 90. Mediators are assessed at 2 months, and outcomes are assessed at 4 months.
[1]Functional well-being.
[2]Emotional well-being.
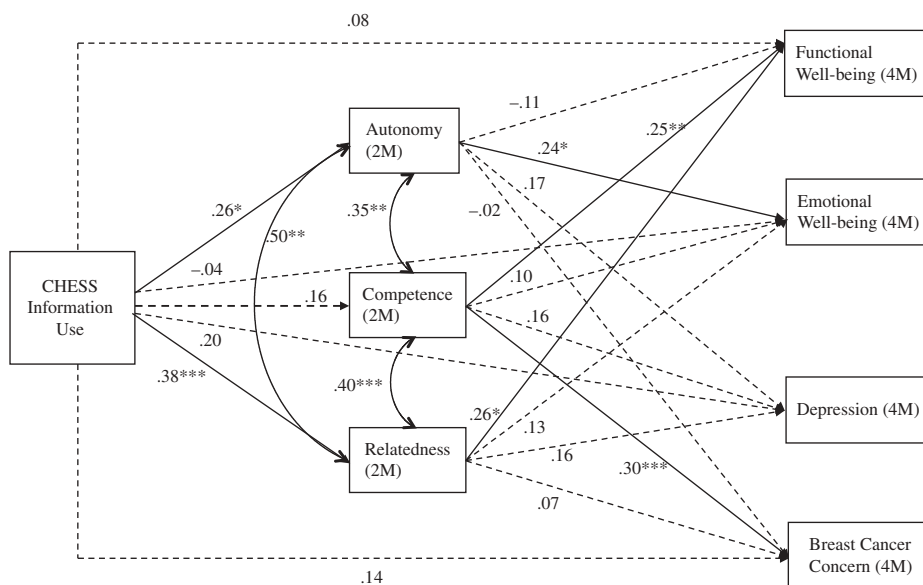[3]Breast cancer concern.
*p ≤ .05; **p ≤ .01; ***p ≤ .001.

Figure 1. Uncorrelated parallel model of the mediating roles of autonomy, competence and relatedness on breast cancer patients' quality of life. All the coefficients are standardized. $N = 90$. Significance: *$p \leq .05$, **$p \leq .01$, ***$p \leq .001$. $R^2_{(FWB)} = .52$, $R^2_{(EWB)} = .52$, $R^2_{(D)} = .43$, $R^2_{(BCC)} = .49$.

Fit indices for the uncorrelated parallel model indicated that it was a poor fit to the data. In particular, the likelihood ratio test (LR) was significant ($\chi^2 = 73.16$, $p = .00$). Similarly, both the Comparative Fit Index (CFI) (.84) and the Tucker–Lewis Index (TLI) (.34)[2] indicated an inadequate fit, and the root mean square error of approximation (RMSEA) also indicated a very poor fit (.14).[3] The hypothesis predicting mediation of all three SDT components (H1) was thus generally not supported in the uncorrelated parallel model.

Correlated parallel model

Engagement with the CHESS system had no direct effects on quality-of-life outcomes in the parallel model in which the mediators were allowed to covary (Figure 2). System use

Figure 2. Correlated parallel model of the mediating roles of autonomy, competence and relatedness on breast cancer patients' quality of life. All the coefficients are standardized. $N = 90$. Significance: *$p \leq .05$, **$p \leq .01$, ***$p \leq .001$. $R^2_{(FWB)} = .52$, $R^2_{(EWB)} = .54$, $R^2_{(D)} = .46$, $R^2_{(BCC)} = .49$.

[2]Acceptable values for TLI and CFI are over .9 (Kaplan, 2009, 2004).
[3]Brown and Cudeck (1993) recommend RMSEA below .08, with preference for values < .06.

demonstrated a significant direct effect on autonomy (β = .18, p = .01) and relatedness (β = .27, p = .00), but not on competence (β = .13, p = .12). In turn, there was a significant, positive relationship between autonomy and emotional well-being (β = .30, p = .02). Similarly, there was a significant positive relationship between relatedness and functional well-being (β = .33, p = .03). Although competence was not significantly affected by intervention engagement, competence did positively influence functional well-being (β = .29, p = .01) and breast cancer concerns (β = .35, p = .00). Significant correlations between the mediators suggest strong positive relationships between autonomy, competence, and relatedness. No other effects were significant in the model.

Similar to the uncorrelated parallel model, the correlated parallel model suggested that the indirect effect from CHESS engagement to functional well-being was significantly mediated by perceptions of relatedness (Z = .10, p = .04), with no other significant indirect effects through the SDT pathways. This model had a good fit to the data (χ^2 = 26.45, df = 24, p = .33; CFI = .99, TLI = .96; RMSEA = .03). Again, H1 received little support from the correlated parallel model.
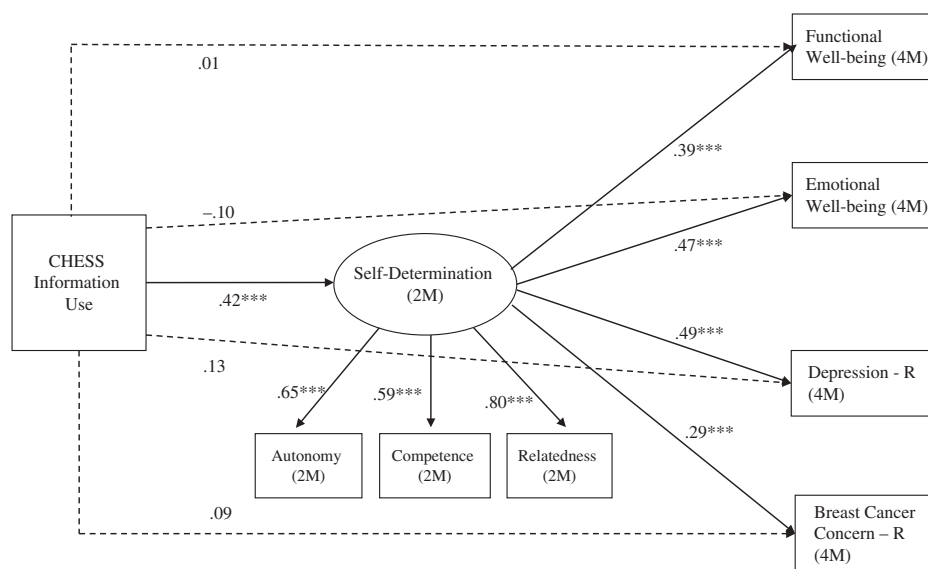
Latent model

Results from the latent model show that while there were no direct effects of CHESS engagement on participants' quality-of-life measures, CHESS engagement did yield significant effects on self-determination, which was positively associated with quality-of-life indicators (Figure 3). CHESS engagement had a significant positive effect on the latent variable (β = .42, p = .00). In turn, there was a significant positive association between self-determination and quality-of-life outcomes: functional well-being (β = .39, p = .00), emotional well-

being (β = .47, p = .00), depression (β = .49, p = .00),[4] and breast cancer-related concerns (β = .29, p = .00).

The test of mediation showed that there was significant mediation in the latent model. The effect CHESS engagement on functional well-being was mediated by the latent variable (Z = .16, p = .01). The impact of CHESS engagement on emotional well-being was also mediated by the latent self-determination construct (Z = .20, p = .00). CHESS engagement also reduced depression with the effect being mediated through the latent construct (Z = .20, p = .00). There was also an effect from CHESS engagement to reduced breast cancer concerns that was mediated through self-dermination (Z = .12, p = .03). The remaining direct effects of intervention engagement on quality of life were not significant. In conclusion, the hypothesis predicting mediation (H1) was supported using a latent model across all quality-of-life outcomes. Fit indices demonstrated that the latent model fit the data well (χ^2 = 50.47 (df = 50), p = .46; CFI = .99, TLI = .99; RMSEA = .01), supporting the view that CHESS engagement had indirect effects on quality-of-life outcomes through enhanced self-determination, understood as a holistic, intertwined construct composed of competence, relatedness, and autonomy (H1).

To formally test H2, which predicted that the relationship between CHESS system use and quality-of-life indicators through the SDT components would be best represented by a model in which the mediators are conceptualized as deeply intertwined, the BIC and AIC for the models were compared. Between the parallel model with uncorrelated mediators (AIC = 1178.48; BIC = 1425.96) and the parallel model with correlated mediators (AIC = 1140.61; BIC = 1395.59), the latter model had better fit. The differences in AIC (−37.87) and BIC (−30.37) are substantial. In turn, the latent model (AIC = 1113.34; BIC = 1303.33;) was far superior to the

Figure 3. Latent model of the mediating role of self-determination on breast cancer patients' quality of life. All the coefficients are standardized. N = 90. Signficance: *p ≤ .05, **p ≤ .01, ***p ≤ .001. $R^2_{(FWB)}$ = .51, $R^2_{(EWB)}$ = .59, $R^2_{(D)}$ = .52, $R^2_{(BCC)}$ = .48.

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[4]Depression and breast cancer-related concerns are reverse coded. Positive coefficients between these outcomes and SDT mediators indicate a decrease in depression and/or breast cancer-related concerns.

correlated parallel model, with sizable differences in AIC (−27.27) and BIC (−92.26) that strongly favored a latent variable approach as the best fitting formulation (Kaplan, 2009, 2004). The hypothesis predicting progressively enhanced performance with increasingly interrelated mediators was supported.

The research question exploring the relative contribution of autonomy, competence, and relatedness was addressed by examining the measurement component of the latent model, the superior model. The three SDT components demonstrated significant factor loadings on the self-determination latent variable. A Wald test indicated that the contributions of autonomy (λ = .65, p = .00), competence (λ = .59, p = .00), and relatedness (λ = .80, p = .00) to self-determination were not statistically different from each other (see Figure 3; Wald (χ^2) = 1.43, df = 2, p = .49). Hence, evidence suggests that the SDT components equally contributed to heightened self-determination among system users. In turn, heightened self-determination promoted emotional and functional well-being and reduced depression and breast cancer concerns.

Given the unanimous evidence in terms of relative fit, coupled with superior overall model fit, these findings support the latent model as the model that best fits these data. This evidence supports the thesis that the intervention effects occur as a result of deeply intersected and mutually reinforcing relationships between SDT components, rather than the assumption that the constructs inherent in SDT affect quality-of-life outcomes discretely.

Discussion

Based on SDT, this study tested the mediating role of autonomy, competence, and relatedness in the relationship between engagement with the CHESS system and breast cancer patients' quality of life in terms of functional well-being, emotional well-being, depression, and breast cancer concerns. While past research has investigated the effect of interactive communication systems such as CHESS on system users' improved psychological needs and quality of life, these studies focused primarily on direct effects of the system on improved outcomes, such as perceived social support, health competence, emotional well-being, and depression (Gustafson et al., 2008). These studies shed light on the positive effects of the intervention. However, from the perspective of SDT, interactive communication systems should satisfy psychosocial and psychological needs, which in turn yield improved quality of life in terms of mental health and well-being. This relationship has gone overlooked.

We attempted to clarify the nature of effects to better understand how the CHESS system contributes to positive health outcomes. To that end, the effects of engagement with the system across three models was tested and compared: one that assumes the SDT constructs are discrete and unrelated (i.e., uncorrelated parallel model), another that supposes that the mediating pathways are discrete but related (i.e., correlated parallel model), and a third that advances the view that autonomy, competence, and relatedness are acutely interwoven and jointly fortifying, arguing for a reduction in dimensions (i.e., latent model). This third formulation best

fits the data, and generates a set of findings that are theoretically consistent, which accounts for the mediating role of SDT components in channeling CHESS effects onto a range of quality-of-life indicators among the population under study.

The fact that the latent model outperformed the parallel models suggests that the relationship between the SDT mediators is more complicated than previous research would suggest. It is likely that the effects of competence, autonomy, and relatedness are deeply interconnected, jointly constitutive, and mutually reinforcing. The women who were more engaged with CHESS, such that they gained more from the system, demonstrated significantly higher self-determination, measured as a latent variable, which in turn yielded higher quality of life insofar as reports of depression and cancer concerns were diminished and functional and emotional well-being were bolstered 2 months later. A Wald test of the measurement component of this model revealed that contributions of autonomy, competence, and relatedness to the self-determination latent variable were not statistically distinguishable from one another.

Notably, even results from the parallel models suggest that effects of the CHESS system were mediated rather than directly affecting quality-of-life outcomes. However, the pathways of intervention effects were very different, depending on whether the mediators underlying self-determination were allowed to covary—or not. In the parallel models, CHESS effects on functional well-being were mediated through relatedness, but not through autonomy or competence. Further, there was no significant mediation of intervention effects for other quality-of-life indicators. Relatedness was associated with both intervention engagement and emotional well-being, but the mediation path was nonsignificant. Enhanced competence promoted functional well-being and reduced breast cancer concerns and depression, but those effects could not be attributed to the intervention in the model. Conceptualizing SDT as a multidimensional concept, rather than a holistic, latent variable, leads to very different conclusions about CHESS's efficacy and the pathways through which those effects occur.

The uncorrelated parallel model would suggest that the intervention was largely unsuccessful at improving quality of life. Based on this model, one might also question the efficacy of the intervention for promoting competence. From this perspective, although engagement with the system may enhance relatedness, those effects did not follow through to improved quality of life. These results are inconsistent with theoretically derived hypotheses. Further, the configuration of the relationships inherent in the parallel model is not an appropriate representation of the processes at work, evidenced by poor model fit.

The correlated model was a better fit to the data, but painted a similar picture. The correlated parallel model suggested that any impact of intervention engagement on quality of life occurs through enhanced relatedness. No other mediation pathways were significant in this model. From a practical perspective, this model suggests that optimal attention should be paid to intervention components that enhance relatedness. This model had a good fit to the data.

However, when the model was estimated using a latent variable representing self-determination, each of the proposed mediators contributed strongly to the latent variable and each of the outcomes were affected by the self-determination construct. Further, the latent model was an excellent fit to the data in an absolute sense, and produced superior fit indices relative to the parallel models. Taken together, these results suggest that the effects of CHESS system engagement on quality of life are more appropriately described by a model in which the components of self-determination are assumed to be intertwined and jointly constituted, rather than one in which they are understood as discrete, parallel dimensions.

Furthermore, the latent model suggests that the intervention was rather successful. Relative to their counterparts, women who reported getting more information from the intervention system were likely to experience greater changes in competence, relatedness, and autonomy, which contributed equally to self-determination. In turn, women who experienced heightened self-determination were likely to show improved quality of life 2 months later. This model, which accounts for substantial proportions of variance in each of the outcomes, suggests that the channeling of intervention effects through SDT results in improvements for multiple dimensions of quality of life. This finding is consistent with the theoretical propositions.

Learning whether the effects of the CHESS system are discrete or intertwined has important implications for understanding whether specific components of the CHESS system may be particularly effective for producing positive health outcomes. Results from the Wald test indicate that autonomy, competence, and relatedness are equally weighted factors contributing to self-determination, which serves as a channel for the impact of engagement with cancer support system. This finding suggests that replications of the intervention would be well advised to continue including components that focus on these three prerequisites to positive human development in conjunction with one-another rather than singularly.

This study also suggests that there are complicated and intriguing relationships between the SDT constructs, though the nature of those relationships was not probed in this study. Numerous possibilities exist for the relationships between the mediating variables (Hayes, 2009, 2013). It is possible that the variables demonstrate contingent relationships—interactions, which are not specified in this study. They also may be reciprocal in nature, operating in a virtuous circle, or related in a serial manner, with one mediating the effect of another. Moderated mediation, where the effects of one mediator are contingent on another, is also plausible. Future research that untangles the interrelationships between competence, autonomy, and relatedness would provide a valuable contribution to communication intervention design and implementation.

Evaluations of SDT-based interventions may benefit from acknowledging the interconnectedness of these mediators in data analyses. This study suggests that constraining the relationships between the mediators may conceal important intervention effects. The models that assumed that improved quality of life was mediated by three mutually exclusive or linearly related theoretical constructs were far inferior to a model that assumed that the proposed mediators were interconnected and interdependent indicators of self-determination. Analytically, if the parallel model were adopted to test intervention effectiveness, the results would suggest a single, small indirect effect of campaign engagement. Practically, the lack of support for this model may lead researchers, practitioners, and funding bodies to conclude that the intervention was rather ineffective. However, when a statistical model that respects the complicated nature of the relations between mediators is utilized, results invite a very different interpretation.

While this study was carefully designed and implemented, it is still subject to limitations. Although the CHESS intervention has demonstrated success among a range of contexts (Gustafson et al., 2008, 2001), these data represent primarily middle-class, highly educated women with breast cancer, from the Midwest, who received training for using the system. The sample only represents women who accepted an invitation to participate from their clinicians. Thus, the generalizability of the study results may be limited. For instance, the sample may not include women who are disconnected from or unable to access medical treatment. Second, the extent to which engagement with the system promotes autonomy, competence, and relatedness, or the extent to which each of these components contributes to quality of life, may vary depending on skills, abilities, or resources. Despite this, the process by which the intervention affects health outcomes should be relatively consistent. Finally, the impacts of specific CHESS system components on the SDT mediators were not tested, which also suggests another important avenue for future research.

While it is important to evaluate whether there are positive and meaningful effects of interventions on health outcomes, it is equally important to understand the mechanisms through which interactive communication systems can improve health and well-being. An understanding of the pathways by which CHESS use improves health outcomes promotes replication of theory-driven health interventions using other computer-mediated support systems. Comprehensive online health interventions, like CHESS, can promote competence, autonomy, and relatedness, and consequently enhance quality of life for women experiencing a recent breast cancer diagnosis. Based on this study, we now have a better understanding of how and why that happens. Considering that the latent model provided a statistically superior explanation of effects, results suggest that when it comes to implementing and evaluating this SDT guided intervention, the whole is greater than the sum of its parts.

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