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Daily Illness Appraisal and Collaboration in Couples With Type 1 Diabetes

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Objective: Dyadic coping theories posit that spousal involvement may benefit illness management through collaborative and supportive (C&S) strategies and shared illness appraisals. Illness appraisals have only been examined as individual differences rather than fluctuating daily as individuals manage the difficult Type 1 diabetes regimen. The study examined how daily illness appraisals of individuals with Type 1 diabetes and their spouses were linked to spouses' daily C&S strategies and whether C&S strategies were most beneficial for daily diabetes outcomes when they occurred in the context of shared illness appraisals. *Method*: Couples (N = 199) in which one person had Type 1 diabetes (M age patients = 46.81; 52.3% female; spouses = 46.40, 47.5% female) completed a 14-day diary assessing illness appraisals (ranging from nonshared through shared) and spouses' C&S strategies. Patients reported daily self-regulation failures, self-care behaviors, and perceived coping effectiveness. Daily blood glucose was gathered from glucometers. Results: Multilevel models indicated both within-person and between-person effects of patients' and spouses' illness appraisals on C&S strategies with higher shared illness appraisals associated with greater C&S strategies. Greater shared illness appraisals were associated with fewer self-regulation failures and better self-care. C&S strategies were associated with lower self-care and higher blood glucose levels. Appraisal interacted with C&S strategies such that C&S strategies were associated with more self-regulation failures, lower self-care, and lower perceived coping effectiveness when patients reported lower shared appraisals. Conclusions: Results suggest that C&S strategies may be more detrimental for diabetes management when individuals view diabetes as less shared.

Keywords: Type 1 diabetes, couples, dyadic coping, illness appraisal, support

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Type 1 diabetes is a common chronic illness affecting some 1.25 million Americans, the majority of whom are adults (Juvenile Diabetes Research Foundation, 2019). It is accompanied by significant financial (Yang et al., 2018) and psychosocial burden (Young-Hyman et al., 2016). Diabetes management involves a difficult daily process coordinating multiple self-care behaviors: checking blood glucose, administering insulin, calculating carbo-

hydrates, and exercising (Chiang, Kirkman, Laffel, Peters, & the Type 1 Diabetes Sourcebook Authors, 2014). In adults these behaviors occur in the context of romantic relationships (Wiebe, Helgeson, & Berg, 2016). Individuals with diabetes who report a higher quality relationship report greater spousal support for selfcare behaviors (Khan et al., 2013; Stephens et al., 2013) and higher quality of life and lower negative impact of the illness (Trief,

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Himes, Orendorff, & Weinstock, 2001). Higher quality relationships may facilitate daily diabetes management through collaborative discussions about how to solve daily problems and the provision of emotional support when problems arise.

Dyadic and communal coping theories posit that spousal involvement may benefit chronic illness management through the strategies couples employ as well as how couples appraise the illness (Badr & Acitelli, 2017; Berg & Upchurch, 2007; Bodenmann, 1997; Helgeson, Jakubiak, Van Vleet, & Zajdel, 2018; Lyons, Mickelson, Sullivan, & Coyne, 1998). One way to measure illness appraisal is to explicitly ask patients and their partners whether they view the illness as the patient's individual issue or a shared issue (Berg & Upchurch, 2007; Helgeson et al., 2018). These theories further hypothesize that the benefit of collaborative and supportive (C&S) strategies for illness outcomes may be enhanced when patients or spouses appraise the illness as shared, as such strategies are consistent with the view that the illness is a joint problem. When the illness is viewed as solely the patient's problem, C&S strategies may be perceived as intrusive and associated with poorer diabetes management and mood. Support for this hypothesis comes from studies of parents and adolescents where collaboration was beneficial for coping effectiveness when adolescents appraised Type 1 diabetes as shared with parents, but was detrimental when the illness was viewed as theirs alone (Berg et al., 2009). In couples with Type 2 diabetes, support for diet was associated with less diabetes distress when individuals viewed the illness as shared with their spouse, but unrelated to distress when the illness was not shared (Stephens et al., 2013). With the sample of couples used in the current article, we previously found that patients' perceptions of C&S strategies (measured via a survey) were associated with better physical functioning and less diabetes distress when they appraised the illness as shared but more diabetes distress when they viewed the illness as theirs alone (Helgeson et al., 2019). Such results may help to explain findings from a recent meta-analysis (Song, Nam, Park, Shin, & Ku, 2017) indicating that support may be less beneficial overall for those with Type 1 versus Type 2 diabetes. That is, C&S may be largely beneficial when patients and partners appraise the illness as shared.

Research thus far has treated illness appraisals as a characteristic of the individual, with individuals categorized as appraising the illness as the patient's alone or as shared within a romantic relationship (Helgeson et al., 2018). However, appraisals and C&S strategies may fluctuate on a daily basis especially for an illness such as Type 1 diabetes that involves a difficult daily regimen. Illness appraisals could fluctuate on a daily basis as partners are perceived as more or less involved in collaborative or supportive ways. Further, illness appraisals may fluctuate for some individuals but operate as an individual difference variable for others.

In the present study we examined at a daily level how both patients and partners appraised the illness and whether fluctuations in appraisals were linked to C&S strategies. Examining both within-person (WP) and between-person (BP) links of illness appraisals to C&S strategies allows for an assessment of whether changes in illness appraisal on a daily basis are linked to changes in C&S strategies within persons and whether individuals with greater shared illness appraisals overall also engage in more C&S strategies. To the best of our knowledge, no daily diary studies have examined daily illness appraisal and collaboration and support in couples with Type 1 diabetes. Consistent with theories of dyadic and communal coping, we expected there to be a strong relation between illness appraisals and C&S strategies but did not have predictions whether this would occur primarily via WP or BP effects.

Daily illness appraisal and C&S strategies may also relate to daily diabetes outcomes-specifically, self-regulation failures, self-care, blood glucose mean, and perceived coping effectiveness. In Type 2 diabetes, daily spousal support for dietary behaviors (Stephens et al., 2013) and exercise (Khan et al., 2013) were associated with better self-care. C&S strategies may be more predictive of diabetes outcomes than illness appraisals as it is the specific ways that spouses provide support and assistance that aids in the completion of daily self-care tasks. However, illness appraisals could be more predictive of diabetes outcomes as when illness appraisals are shared, patients may be more receptive to collaboration and support from their partner (Helgeson et al., 2019). Further, patients' and partners' appraisals and collaborative strategies may show differential relations to diabetes outcomes. A meta-analysis (Karan, Rosenthal, & Robbins, 2019) indicated that partners' illness appraisals were more predictive than patients' illness appraisals of relationship and health outcomes, perhaps because partners' appraisals indicate an openness to interact in a more collaborative manner.

The study examined how illness appraisals of patients and partners were linked to their perceptions of partners' C&S strategies on a daily level and how illness appraisals and C&S strategies were associated with diabetes outcomes (partners are referred to as spouses as most individuals were married). First, we examined whether illness appraisal varied on a daily basis and whether patients and spouses would differ in their reports of illness appraisal and C&S. Given our prior work with this sample using interview measures of illness appraisal and C&S (Helgeson et al., 2019), we expected that patients might report less shared appraisals and C&S strategies than spouses, but did not have predictions about whether illness appraisal would vary daily or be more of an individual difference characteristic for patients or spouses. Second, we examined the daily links between illness appraisals and C&S strategies, expecting there to be a close link between the two given theories of dyadic coping. As dyadic coping has been associated with better relationship satisfaction (Falconier, Jackson, Hilpert, & Bodenmann, 2015), we examined whether illness appraisals predicted over and above relationship quality. Because we had reports of illness appraisal from both patients and spouses, we tested whether both people's views of the illness as shared was a stronger predictor of outcomes by testing the interaction between patient and spouse illness appraisal. Third, we examined associations of patient and spouse daily appraisal, spouse C&S strategies, and the interactions between appraisal and spouse C&S strategies on metrics of daily diabetes management. We did not have a priori predictions as to whether daily illness appraisals or C&S strategies would be most predictive of outcomes, as no prior research has compared these two aspects of dyadic coping on a daily basis. Finally, we predicted that C&S strategies would be most related to better outcomes when diabetes was viewed as a shared illness.

Method

Participants

Participants were eligible to participate if patients were 25 years of age or older, had a diagnosis of Type 1 diabetes for at least one year and were taking insulin within 1 year of diagnosis, spoke English as their primary language (required for cognitive testing in the larger study), and were married or in a cohabiting relationship for at least one year. Eligible couples (N = 199; 398 individuals, 199 patients) were enrolled and completed study measures. Participants were mostly married (91.5%) and in heterosexual relationships (97%). The average length of romantic relationship was 19.36 years (SD = 14.56). Patients were on average 46.81 (SD =13.95) years old, 52.3% were women, and were generally well educated (59.9% had a college degree or beyond). Spouses were on average 46.40 (SD = 14.17), 47.5% women, and also well educated (53.1% with a college degree or beyond). Patients were largely non-Hispanic White (89.9%), as were spouses (96.9%). Patients reported having lived with diabetes for an average of 26.97 (SD = 13.88) years, 68.3% reported using a pump for insulin delivery, and average HbA1c was above current American Diabetes Association (ADA; 2019) guidelines (<7.0%; M = 7.57, SD = 1.06). Study procedures were approved by the Institutional Review Boards at both sites (i.e., University of Utah and Carnegie Mellon University). All participants provided informed consent.

Procedure

Participants were recruited from two university-affiliated endocrinology clinics in Utah and Pennsylvania. At the Pennsylvania site, patients were approached in the clinic by their provider who obtained permission to release their name to the project director. If patients agreed, the director explained the study to patients, if they agreed to participate, spouse information was obtained and if spouses agreed, couples were enrolled. Of the 206 patients approached, four declined to have their name forwarded, 47 were ineligible, 57 declined participation, and six could not be reached. Thus, 92 couples were scheduled and included in the study. At the Utah clinic, a research assistant explained the study to patients, if they agreed, partner information was obtained. Of the 319 patients approached and screened for eligibility, 66 were deemed ineligible and 118 declined participation. Of the remaining 135 couples, 107 were scheduled and included in the study. The final sample included 199 couples across both sites.

Once patients and spouses were recruited for the study, they were e-mailed links to online surveys (that included consent) to complete separately at home prior to the in-lab visit. Couples completed an additional online survey in the lab visit where they were trained how to complete a daily online diary assessment that included illness appraisals, C&S strategies, and for patients' diabetes outcomes. Patients used a study glucometer during the 14-day assessment. Individuals received an e-mail reminder if they had not completed the diary by 9 p.m. On average, patients completed 13.82 days (SD = .56) and spouses completed 13.71 days (SD = .86) out of a possible 14 days. Individuals were compensated up to \$225 for completing all parts of the study.

HbA1c. Both sites used the DCA Vantage (Malvern, PA) to obtain a measure of patient hemoglobin A1c (HbA1c) during the laboratory visit.

Relationship quality. Patients and spouses completed the 16item Couples Satisfaction Index, (Funk & Rogge, 2007). Reliability was excellent ($\alpha = .97$ for patients, $\alpha = .98$ for spouses).

Daily Diary

Daily Illness Appraisal. Patients and spouses were asked how they viewed diabetes on that day. For patients and spouses, response options included (1) completely my own issue, (2) mostly my issue, (3) both our issue, (4) mostly my partner's issue, (5) completely my partner's issue. For patients, there were very few instances in which they chose mostly my partner's issue (three of 2,688 instances) or completely my partner's issue (two of 2,688 instances). Similarly, there were only two instances in which spouses viewed diabetes as "completely my issue" and 17 instances as "mostly my issue." Because these responses were difficult to interpret (i.e., why patients and spouses would regard diabetes as the spouse's problem) and because there were extremely low frequencies, we deleted days for which patients and spouses viewed diabetes as mostly or completely the spouse's issue. We reverse coded spouses' illness appraisals, resulting in a consistent three-point scale with a higher score reflecting higher shared appraisal for both patients and spouses. Mean illness appraisal across the 14 days of the diary were correlated with an interview-based measure of illness appraisal (Helgeson et al., 2019; r = .46, p < .001 for patients, and r = .60, p < .001 for spouses).

Daily collaboration and support. Daily perceptions of spouse collaboration and support (daily C&S) were measured using study-created items, many of which were adapted from Helgeson, Jakubiak, Seltman, Hausmann, and Korytkowski (2017). Patients rated on a 1 (not at all) to 5 (a lot) scale how involved their spouse was in their diabetes today on eight-items (e.g., helped me figure out how to care of my diabetes, see the online supplemental materials, Table S1, for all items). Spouses were asked to rate on the same scale how much they were involved with the patient. The eight items were subjected to an exploratory factor analysis procedure suitable for daily diary items in MPlus (Version 8), which revealed that these items loaded onto a single factor. WP reliability was λ_{00} = .96. The mean of these C&S strategies across the 14 days of the diary was highly related to a survey-based measure of instrumental and collaborative strategies patients completed (r = .69, p < .001; Helgeson et al., 2019).

Daily self-regulation failures. Patients reported on their daily experience of eight failures in self-regulation involving cognitive, behavioral, and emotional control in the context of monitoring blood glucose (BG), a difficult daily behavior ("I kept putting off my BG testing and I had a lot going on"; see Table S2 in the online supplemental material), using a 1 (*strongly disagree*) to 5 (*strongly agree*) scale (Berg et al., 2014). Average scores were used as a measure of daily self-regulation failures, with higher scores representing more self-regulation failures (Berg et al., 2014). WP reliability was λ_{00} = .96.

Daily self-care behaviors. Daily self-care was measured using five or six (one extra item for those on a pump or CGM) items from a shortened version of the Self-Care Inventory created for use in daily diaries (Berg et al., 2014). Participants rated how well they followed recommendations from their health care provider for self-care behaviors (e.g., administering insulin dose as recom-

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mended; see Table S3 in the online supplemental material) in the past 24 hr from 1 (*did not do it*) to 5 (*did it exactly as recommended*). WP reliability was $\lambda_{00} = .97$. An average daily score was used.

Daily mean blood glucose. Daily BG was measured using OneTouch Verio IQ glucometers (Malvern, PA). Participants were instructed to use this meter as they would their regular glucometer across the 14-day daily diary portion of the study and values were uploaded by study staff after completion of the diary. A daily mean was computed to estimate average BG level across a 1-day (24-hr) period. Analyses were also conducted using average risk range (McCall & Kovatchev, 2009) that addresses challenges in scaling of BG. These results were largely identical to those with BG mean and we report the more standard BG mean analyses.

Daily perceived coping effectiveness. Each day patients described the most stressful event of the last 24 hr in dealing with their diabetes. If they mentioned a stressful event, they reported how well they handled the event on a 1 (*very badly*) to 5 (*very well*) scale.

Analysis Plan

Missing data in the diary averaged at 1.5%, with BG mean being an exception at 5.9% missingness. There were no missing data for the survey measures. As missing data were minimal and the multilevel models used maximum likelihood, based on estimation procedures, we did not estimate missing data. The analyses utilized multilevel models (Raudenbush, Bryk, Cheong, & Congdon, 2000) performed in IBM SPSS Mixed (Version 25; IBM Corp., 2017). All models included both WP (daily) and BP (average across 14 days) effects (Hoffman & Stawski, 2009). WP effects were personcentered (individuals' own average across the 14-days), and BP effects were grand mean centered. Site differences were examined with patients at the Pittsburgh site reporting fewer self-regulation failures than those from Utah, thus site was covaried. All models included day of daily diary, relationship quality, site, and gender. Length of diagnosis and pump status (coded as -.5 not on pump, .5 on a pump) were included as covariates in models of BG mean. Random effects were allowed on the intercept. For analyses predicting C&S strategies, independent variables were daily illness

Table 1

Means and Correlations	of	Primary	Study	Variables
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appraisal (WP and BP) for both patient and spouse and the interaction between patient and spouse appraisal (both WP and BP).

For diabetes management outcomes, separate models for illness appraisal and C&S on diabetes management outcomes were tested for patients' and spouses' perceptions, as a model that combined both patient and spouse would have included too large a number of independent variables to be tested in a single model. Independent variables were daily illness appraisal (WP and BP), spouse C&S strategies (WP and BP) and the WP (daily), BP (average), and cross-level (WP C&S by BP illness appraisal) interactions between illness appraisal and spouse C&S strategies. We tested all three interactions simultaneously (within, between, and the cross-level interaction), as we did not have specific predictions as to whether illness appraisal would fluctuate on a daily basis or be primarily an individual difference characteristic. Significant interactions were decomposed one standard deviation above and below the mean, and simple slopes were tested.

Results

Preliminary Analyses

Descriptive statistics and correlations among study variables are presented in Table 1. A paired samples t test indicated significant mean differences between patients and spouses in illness appraisals, t(198) = -14.33, p < .001, with patients viewing diabetes as less shared than did spouses on average across the diary period. Patients most frequently appraised diabetes as "mostly their issue" (39.9% of days), followed by "completely my issue" (35.9% of days), and least frequently as "both of our issue" (24.4%). Spouses, however, most frequently viewed diabetes as "both of our issue" (59% of days), followed by "mostly the patient's issue" (34.7% of days) and least frequently as "completely the patient's issue" (6.3% of days). No significant differences were found between patients and spouses in reports of C&S strategies. On average patients' illness appraisals were associated modestly with spouses' appraisals as were patients' and spouses' C&S strategies. No age or gender differences were found in illness appraisal or C&S strategies.

Variable	М	SD	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Patient: 14-day <i>M</i> illness appraisal	1.88	63													
2. Spouse: 14-day <i>M</i> illness appraisal	2.53	.50	.37**												
3. Patient: 14-day M C&S strategies	2.14	.92	.75**	.30**											
4. Spouse: 14-day M C&S strategies	2.18	.83	.41**	.43**	.51**										
5. Patient: 14-day M self-regulation failures	1.57	.64	06	18^{**}	001	.01	_								
6. Patient: 14-day M self-care	4.42	.56	.07	.20**	06	05	64**								
7. Patient: 14-day M blood glucose	175.52	35.22	004	06	.05	02	.39**	36**							
8. HbA1c	7.57	1.06	04	03	03	02	.32**	33**	.59**						
9. Patient gender, female (%)	52.3%		07	.13	12	02	07	.23**	03	00					
10. Patient age	46.81	13.95	.09	.07	03	11	18^{*}	.28**	03	.12	08	_			
1. Length of diagnosis	26.97	13.88	.07	.06	06	05	11^{**}	.29**	07	.02	.02	.63**	—		
2. Patient relationship quality	65.74	14.27	.37**	.20**	.40**	.24**	*18*	.16*	06	07	03	10	09		
3. Spouse relationship quality	63.93	15.06	.23**	.08	.21**	.15*	09	.09	08	20	.00	13	09	.56**	_

Note. C&S = Collaborative and supportive strategies.

p < .05. p < .01.

Unconditional models to examine WP and BP variability in illness appraisal calculated via intraclass coefficients indicated that 65% of the variability in illness appraisal was BP for patients and 63% for spouses. For C&S strategies, 66% of the variability was BP for patients and 60% for spouses. Given the strong BPs component to both patient and spouse illness appraisal and C&S strategies, we investigated the WP variability further to determine

if some individuals did not vary in their illness appraisals and strategies: 21.6% of patients and 42.7% of spouses did not vary across days in their illness appraisals. Only 1.5% of patients and .5% of spouses did not vary across days in C&S strategies.

Link Between Illness Appraisals and C&S Strategies

Analyses of illness appraisal predicting C&S strategies revealed strong WP and BP effects of illness appraisal on C&S strategies (see Table 2). For patients, the WP effect revealed that on days that individuals reported greater shared appraisal than their own average, they reported greater C&S strategies. Further, a BP effect indicated that patients who perceived greater shared appraisal than the average of the sample reported greater C&S strategies. There was a WP spouse effect, indicating that when spouses perceived the illness as more shared than their average, there was an additional effect toward higher C&S strategies. The BP Patient \times Spouse appraisal interaction was significant (see Figure 1). Simple slopes testing indicated that both slopes were significant, with the link between patient appraisal and C&S strategies stronger when spouses also reported higher shared appraisal across the 14 days

Table 2

Multilevel	Models Predicting Daily Collaborative and	
Supportive	Strategies From Illness Appraisal	

	Collaborative and supportive strategies
Independent variable	B (SE)
Patient	
Intercept	2.16 (.07)***
Day	01 (.003)***
Patient appraisal (WP)	.56 (.03)***
Patient appraisal (BP)	.93 (.08)***
Spouse appraisal (WP)	.18 (.03)***
Spouse appraisal (BP)	.12 (.10)
Patient Appraisal (WP) \times Spouse Appraisal (WP)	.12 (.08)
Patient Appraisal (BP) \times Spouse Appraisal (BP)	.37 (.16)*
Patient relationship quality	.01 (.003)**
Site	.02 (.09)
Gender	14 (.09)
Spouse	
Intercept	2.16 (.09)***
Day	02 (.003)***
Spouse appraisal (WP)	.42 (.03)***
Spouse appraisal (BP)	.57 (.11)***
Patient appraisal (WP)	.27 (.03)***
Patient appraisal (BP)	.34 (.09)***
Spouse Appraisal (WP) \times Patient Appraisal (WP)	.04 (.08)
Spouse Appraisal (BP) \times Patient Appraisal (BP)	.17 (.19)
Spouse relationship quality	.004 (.003)
Site	05 (.10)
Gender	.01 (.10)

Note. WP = within-person; BP = between-persons.

p < .05. p < .01. p < .01. p < .001.

(b = 1.12, z = 11.68, p < .001) compared with lower shared appraisal (b = .75, z = 5.91, p < .001). These relations held with controls for relationship quality, which was also associated with perceptions of more C&S strategies. WP and BP effects also were found for both spouse and patient reports of appraisal on spouse's reports of C&S strategies. These results demonstrate a strong link between illness appraisal and the C&S strategies individuals perceive both at the daily level and on average.

Daily C&S Strategies and Diabetes Outcomes and Moderation by Illness Appraisal

Table 3 presents the results from separate multilevel models of patients' and spouses' illness appraisal, C&S strategies, and their interaction predicting patients' diabetes outcomes. All effects reported in the following text control for relationship quality.

Self-regulation failures. A significant WP effect of patient appraisal on self-regulation failures indicated that on days when patients viewed diabetes as more shared than their own average, they reported fewer self-regulation failures. A significant WP and BP effect for C&S strategies indicated that on days when patients viewed greater C&S than their own average, they reported more self-regulation failures and overall. Significant cross-level and BP interactions were found between C&S strategies and illness appraisal. As is shown in Figure 2, Panels A and B, greater daily C&S strategies were associated with greater self-regulation failures for those with lower shared mean appraisals (cross-level interaction b = .07, z = 2.73, p = .01; BP interaction; b = .34, z =2.82, p = .005), whereas C&S strategies were not associated with self-regulation failures for those with higher shared illness appraisals (cross-level interaction b = -.002, z = -.10, p = .92; BP interaction; b = .07, z = .90, p = .37).

A similar analysis was conducted using the spouse's illness appraisal and reports of C&S strategies with only the BP effect of illness appraisal significant. When spouses perceived greater shared appraisal relative to the average of the sample, patients reported fewer self-regulation failures.

Self-care behaviors. For patients' reports of self-care, a significant BP effect of patient's illness appraisal indicated that patients who reported greater shared appraisal relative to the average of the sample reported better self-care. A significant BP C&S effect was found such that patients who reported greater C&S strategies relative to the average of the sample reported lower self-care. Significant C&S by illness appraisal interactions were found at the WP and BP level. As is shown in Figure 2, Panel C, the WP interaction revealed that greater C&S strategies were associated with better self-care for those with low shared appraisal (b = .04, z = 2.46, p = .01), with no association when illness appraisals were more shared (b = -.02, z = -1.34, p = .18). The BP interaction (see Figure 2, Panel D) revealed that greater C&S strategies on average were associated with poorer self-care more strongly for those with lower shared illness appraisal (b = -.36, z = -3.58, p = .0003) compared with higher shared appraisal (b = -.13, z = -2.08, p = .04).

A similar analysis conducted using the spouse's illness appraisal and spouse's reports of C&S strategies revealed a significant WP and BP effect of appraisal, such that greater shared appraisal at both levels was associated with higher self-care. Also, greater C&S strategies (BP) were associated with lower self-care.



Figure 1. Relation between patient appraisals (BP) and patient collaborative and supportive strategies by spouse appraisal (BP).

BG Mean. Only the WP effect of patients' reports of C&S strategies was significant, such that on days in which patients reported greater C&S strategies, they had a higher (worse) mean BG. No other significant effects were found for either patient or spouse perceptions of illness appraisal, C&S, or the interaction between the two.

Perceived coping effectiveness. Analyses of perceived coping effectiveness revealed only a significant cross-level interaction (see Figure 3, Panel A), such that C&S strategies were associated with worse patient perceived coping effectiveness when patient shared illness appraisals were low (b = -.13, z = 2.51, p = .01), but not significantly associated with C&S when shared illness appraisals were high (b = .06, z = 1.48, p = .14).

The same analyses using spouses' illness appraisals and C&S strategies revealed a significant WP and BP effect for C&S such that when spouses' C&S strategies were greater than their average, patients reported lower perceived coping effectiveness. A significant cross-level interaction (see Figure 3, Panel B) revealed a similar pattern as found for patients' reports, with worse patient perceived coping effectiveness when shared illness appraisals were low (b = -.22, z = -4.09, p < .001), but not significantly related when shared illness appraisals were high (b = -.04, z = -.85, p = .40).

Discussion

The results add to the existing literature on dyadic and communal coping by demonstrating a strong link between illness appraisals and C&S strategies both at an individual difference (BP) as well as a daily level (WP). These effects were above and beyond the general quality of the relationship, pointing to the importance of shared illness appraisals for understanding C&S strategies. For patients, across the diary period, when their shared illness appraisals were matched with spouse's shared appraisals, they perceived greater C&S strategies. These effects are consistent with theoretical accounts of dyadic coping (Berg & Upchurch, 2007; Bodenmann, 1997) and communal coping (Helgeson et al., 2018; Lyons et al., 1998) and our prior work with this sample regarding explicit illness appraisals expressed in an interview and a survey measure of C&S strategies (Helgeson et al., 2019).

To our knowledge, the additional WP effects are the first demonstration that illness appraisals vary across days for the majority of the sample and are linked to daily perceptions of the C&S involvement of spouses. Although Zajdel, Helgeson, Seltman, Korytkowski, and Hausmann (2018) measured both illness appraisal and collaboration daily for couples where one person had Type 2 diabetes they averaged the two measures for a daily measure of communal coping. Our results indicate that for the majority of patients and spouses, illness appraisal does not operate as an individual difference, but varies across days together with how they see their spouse involved. Dyadic and communal coping theories typically view shared appraisals as providing a lens through which patients view their spouse's behavior as C&S (Berg & Upchurch, 2007; Helgeson et al., 2018). As both illness appraisal and C&S strategies were measured at the end of the day, it

Multilevel Models Predicting Diabetes Outcomes From Daily Illness Appraisals and Collaborative and Supportive Strategies (C&S)

	Self-regulation failure	Self-care	Blood glucose M	Coping effectiveness
Independent variable	B (SE)	B (SE)	B (SE)	B (SE)
Patient				
Intercept	$1.80(.08)^{***}$	4.19 (.07)***	182.58 (4.76)***	3.63 (.08)***
Day	.003 (.002)	.001 (.002)	.42 (.24)	$02(.005)^{***}$
Appraisal (WP)	07 (.02)**	.02 (.02)	-4.19(2.38)	.03 (.05)
Appraisal (BP)	.13 (.11)	.20 (.09)*	-3.35(6.13)	11(.10)
C&S (WP)	.03 (02)*	.01 (.01)	$3.64(1.73)^*$	04(.03)
C&S (BP)	.20 (.08)*	$25(.07)^{**}$	7.85 (4.89)	04(.08)
Appraisal (WP) \times C&S (WP)	.04 (.03)	$07(.02)^{**}$	4.08 (2.71)	08(.05)
Appraisal (BP) \times C&S (WP)	$06(.03)^{*}$.03 (.02)	3.32 (2.69)	.16 (.05)**
Appraisal (BP) \times C&S (BP)	$21(.09)^{*}$	$.18(.07)^*$	-9.51(4.97)	.14 (.08)
Length of diagnosis			11 (.19)	
Pump status			-2.29(5.68)	
Patient relationship quality	01 (.003)**	.01 (.003)**	32(.20)	.01 (.003)
Site	$23(.09)^{*}$.08 (.08)	-7.38(5.20)	12(.08)
Gender	06(.09)	.24 (.08)**	44(5.28)	13(.08)
Spouse				
Intercept	1.65 (.08)***	4.49 (.07)***	176.95 (5.07)***	3.55 (.08)***
Day	.002 (.002)	.001 (.002)	.41 (.24)	$02(.005)^{***}$
Appraisal (WP)	01(.03)	.04 (.02)*	3.08 (2.82)	.002 (.06)
Appraisal (BP)	32 (.12)**	.30 (.10)**	-4.43(6.49)	.03 (.11)
C&S (WP)	01(.02)	01(.01)	1.79 (1.64)	$13(.03)^{***}$
C&S (BP)	.11 (.07)	$15(.06)^{*}$	1.42 (3.85)	$14(.06)^{*}$
Appraisal (WP) \times C&S (WP)	03(.04)	.003 (.03)	6.54 (3.67)	11(.07)
Appraisal (BP) \times C&S (WP)	.01 (.03)	.02 (.03)	-2.85(3.50)	.18 (.07)*
Appraisal (B) \times C&S (BP)	15 (.14)	.09 (.12)	-5.06(7.90)	.21 (.13)
Length of diagnosis			14 (.18)	
Pump status			-2.08(5.71)	
Spouse relationship quality	003(.003)	.003 (.003)	24 (.17)	.01 (.003)*
Site	17(.09)	.03 (.08)	-5.54(5.20)	16(.08)
Gender	.05 (.09)	23 (.08)**	2.60 (5.30)	.12 (.08)

Note. WP = within-person; BP = between-persons. * p < .05. ** p < .01. *** p < .001.

is also likely that C&S strategies enacted by spouses lead to the appraisal that the illness is more shared. Our results add to the dyadic and communal coping literature by suggesting that appraisal and C&S strategies may vary according to the daily stressors and experiences of couples, in addition to individual differences. This intraindividual variability points to a more dynamic and fluid account of dyadic and communal coping processes, rather than one based on individual differences alone (see also Afifi, Hutchinson, & Krouse, 2006).

Although our results showed a daily association between shared illness appraisals and C&S strategies, for some individuals (especially spouses) there was no variability in illness appraisals across the 14 days of the diary. The greater consistency in spouse appraisal compared with patient appraisal suggests that spouses may be less affected by the daily fluctuations in daily diabetes stressors and experiences. Other data analyses with the present sample indicates that greater variability in illness appraisals in spouses is associated with less secure attachments and poorer diabetes outcomes (Lee et al., 2020). Future work is needed to understand whether variability in appraisals is associated with characteristics of the patient, of the spouse, of the relationship, or of the disease and its associated daily stressors.

Although illness appraisals and C&S strategies were linked, these different aspects of dyadic and communal coping were associated differently with self-regulation, self-care, and BG mean. In general, patients' daily shared illness appraisals and spouses' average shared illness appraisals were associated with better aspects of diabetes management (lower self-regulation failures and better self-care). Illness appraisals may encompass a broader approach to dyadic and communal coping, compared with C&S strategies, that affect how spousal involvement is perceived (Berg & Upchurch, 2007; Helgeson et al., 2018). Illness appraisals may not only link to C&S strategies, but also to lower amounts of negative aspects of spousal involvement such as control and criticizing strategies, to provide a more comprehensive and predictive barometer of felt support. The fact that both patients' and spouses' shared illness appraisals were predictive of better diabetes outcomes lends support for a growing literature on the benefit of shared illness appraisals for couples (Karan et al., 2019). The results indicating that the effects were at the WP level for patients, but largely isolated to the BP level for spouses, is likely because so many spouses had no variability in their illness appraisals.

C&S strategies, however, seemed to be associated with worse outcomes (when significant) and this was especially the case when patients perceived diabetes more generally as less rather than more shared. Rather than C&S strategies leading to poor diabetes outcomes, we think it is more likely that on days in which individuals were doing more poorly, the spouse was more engaged in an effort to improve diabetes management. In our prior work with survey





Figure 3. Panel A: Daily relation of patients' perceptions of collaborative and supportive strategies (withinperson) and coping effectiveness moderated by patients' shared appraisal (between-persons or cross-level interaction). Panel B: Daily relation of spouses' perceptions of collaborative and supportive strategies (withinperson) and coping effectiveness moderated by spouses' shared appraisal (between-persons or cross-level interaction).

measures of illness appraisal and C&S, we also generally found that C&S strategies were not associated with better self-care or HbA1c (Helgeson et al., 2019). The general lack of consistent findings for C&S across both the present and our prior survey results are in contrast with a recent meta-analysis that suggests that social support is beneficial for self-care, though perhaps less so for those with Type 1 than Type 2 diabetes (Song et al., 2017). Given the paucity of research in this area, further studies are needed with a variety of metrics of spousal involvement to understand how spouses may be involved in Type 1 diabetes in a beneficial fashion. C&S strategies may work differently for individuals with Type 1 diabetes as self-care behaviors may be more individually focused (individual must test BG, monitor insulin) than in similar illnesses like Type 2 diabetes (involving more social behaviors like eating and exercise). C&S strategies in the context of Type 1 diabetes may also indicate spousal engagement that is perceived as intrusive rather than helpful.

The interactions between shared appraisal and C&S strategies generally showed that C&S strategies were associated with worse diabetes management when patients (and for perceived coping effectiveness spouses) viewed the illness more as their own issue rather than as a shared issue. In this sense, shared appraisal buffered individuals against the deleterious effects of C&S strategies. Our prior survey work with this sample indicated that C&S

Figure 2 (opposite). Panel A: Daily relation of patients' perceptions of collaborative and supportive strategies (within-person) and self-regulation moderated by patients' shared appraisal (between-persons) or cross-level interaction. Panel B: Patients' perceptions of collaborative and supportive strategies (between-persons) and self-regulation moderated by patients' (between-persons) shared appraisal. Panel C: Daily relation of patients' perceptions of collaborative and supportive strategies (within-person) and self-care behaviors moderated by patients' shared appraisal (within-person). Panel D: Patients' perceptions of collaborative and supportive strategies (between-persons) and self-care behaviors moderated by patients' shared appraisal (between-persons).

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strategies were beneficial for those holding shared illness appraisals, but detrimental for those appraising the illness as their own (Helgeson et al., 2019). However, these effects were stronger for emotional support than for instrumental support. The C&S strategies measured in the diary are similar to those in the survey measures; however, we did not have a separate subscale of emotional support. Future work would benefit from separating emotional from instrumental support (and potentially collaboration) on a daily basis. One WP interaction showed a different interaction pattern with C&S strategies more beneficial for self-care for those with lower shared appraisal on that day. We feel that this interaction should be viewed with caution as its pattern is distinct from the other interactions which converge on one another. In addition, the strong daily link between illness appraisal and C&S strategies makes some of the cells of the interactions (e.g., high shared appraisal with low C&S and low shared appraisal with high C&S) contain a small number of days. In addition, this interaction reflects very small differences in self-care.

The results should be interpreted in the context of some limitations. First, the sample was largely non-Hispanic and White, somewhat advantaged in terms of their socioeconomic status, and experiencing relatively good HbA1c levels (although above current ADA recommendations of an HbA1c level <7.0%, ADA, 2019), limiting the generalizability of our findings. Second, the couples had on average been together for many years, with the result potentially not generalizing to couples of shorter relationship duration. Understanding dyadic and communal coping processes among new relationships would be an important area for future research. Third, our diary assessed illness appraisals, C&S strategies, and diabetes outcomes at a single point in time at the end of the day. This same-time assessment limits our ability to understand whether illness appraisals created the context for C&S strategies or the reverse. Fourth, additional research is needed to understand whether illness appraisals facilitate diabetes outcomes or whether better diabetes outcomes lead to greater illness appraisals. Future research is needed to understand the link between appraisal and C&S strategies via measures that assess appraisals, C&S strategies, and diabetes outcomes throughout the day through ecological momentary assessment.

The results have important implications for research on dyadic coping. Most of the research in this area has focused on the C&S strategies used by spouses rather than whether individuals view the illness as a shared or individual illness (see Helgeson et al., 2018 for a review). These results not only show that how an illness is appraised daily might affect diabetes outcomes, but also the ways in which individuals appraise the illness may be important for understanding whether C&S strategies are beneficial or not. The benefits of a shared illness appraisal are especially important in the context of Type 1 diabetes as most adults with Type 1 diabetes have had diabetes for many years, were often diagnosed in childhood, and have learned to manage diabetes on their own. These contextual features of adult Type 1 diabetes likely contribute to patients being more likely to view diabetes as an individual rather than a shared problem. Research among adolescents has documented the benefits of a shared sense of responsibility with parents (Helgeson, Reynolds, Siminerio, Escobar, & Becker, 2008; Wiebe et al., 2016). Adults with Type 1 diabetes across the life span may benefit in the same way if they are able to share their illness with their partners in a way that communicates their needs, thereby

increasing spouse involvement in diabetes management and spouse responsiveness to patient diabetes challenges. Future research is needed to understand the specific spousal involvement behaviors that are beneficial for daily diabetes self-care and maintaining healthy BG levels.

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